N220

Wireless N-lite USB Adapter

User's Guide

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ZyXEL

www.zyxel.com

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About This User's Guide

Intended Audience

This manual is intended for people who want to configure the N220 using the ZyXEL utility.

Tips for Reading User's Guides On-Screen

When reading a ZyXEL User's Guide On-Screen, keep the following in mind:

- If you don't already have the latest version of Adobe Reader, you can download it from http://www.adobe.com.
- Use the PDF's bookmarks to quickly navigate to the areas that interest you. Adobe Reader's bookmarks pane opens by default in all ZyXEL User's Guide PDFs.
- If you know the page number or know vaguely which page-range you want to view, you can enter a number in the toolbar in Reader, then press [ENTER] to jump directly to that page.
- Type [CTRL]+[F] to open the Adobe Reader search utility and enter a word or phrase. This can help you quickly pinpoint the information you require. You can also enter text directly into the toolbar in Reader.
- To quickly move around within a page, press the [SPACE] bar. This turns your cursor into a "hand" with which you can grab the page and move it around freely on your screen.
- Embedded hyperlinks are actually cross-references to related text. Click them to jump to the corresponding section of the User's Guide PDF.

Related Documentation

- Quick Start Guide

  The Quick Start Guide is designed to help you get up and running right away. It contains information on setting up your network and configuring for Internet access.

- Online Help

  Embedded web help for descriptions of individual screens and supplementary information.

- Support Disc

  Refer to the included CD for support documents.

Customer Support

Should problems arise that cannot be solved by using this manual, please contact your vendor for customer service. Please have the following information ready when you contact the vendor.

- Product model and serial number.
- Date that you received your device.
- Brief description of the problem and the steps you took to solve it.

Document Conventions

Warnings and Notes

These are how warnings and notes are shown in this User's Guide.

Warnings tell you about things that could harm you or your N220.

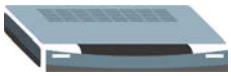
Note: Notes tell you other important information (for example, other things you may need to configure or helpful tips) or recommendations.

Syntax Conventions

- The N220 may be referred to as the "N220", the "device", the "system" or the "product" in this User's Guide.
- Product labels, screen names, field labels and field choices are all in **bold** font.
- A key stroke is denoted by square brackets and uppercase text, for example, [ENTER] means the "enter" or "return" key on your keyboard.
- "Enter" means for you to type one or more characters and then press the [ENTER] key. "Select" or "choose" means for you to use one of the predefined choices.
- A right angle bracket (>) within a screen name denotes a mouse click. For example, **Maintenance > Log > Log Setting** means you first click **Maintenance** in the navigation panel, then the **Log** sub menu and finally the **Log Setting** tab to get to that screen.
- Units of measurement may denote the "metric" value or the "scientific" value. For example, "k" for kilo may denote "1000" or "1024", "M" for mega may denote "1000000" or "1048576" and so on.
- "e.g.," is a shorthand for "for instance", and "i.e.," means "that is" or "in other words".

Icons Used in Figures

Figures in this User's Guide may use the following generic icons.

Wireless Access Point	Computer	Notebook computer
Server	Modem 	Telephone
Internet	Wireless Signal	

Safety Warnings

- Do NOT use this product near water, for example, in a wet basement or near a swimming pool.
- Do NOT expose your device to dampness, dust or corrosive liquids.
- Do NOT store things on the device.
- Do NOT install, use, or service this device during a thunderstorm. There is a remote risk of electric shock from lightning.
- Connect ONLY suitable accessories to the device.
- Ground yourself (by properly using an anti-static wrist strap, for example) whenever working with the device's hardware or connections.
- ONLY qualified service personnel should service or disassemble this device.
- Antenna Warning! This device meets ETSI and FCC certification requirements when using the included antenna(s). Only use the included antenna(s).

Your product is marked with this symbol, which is known as the WEEE mark. WEEE stands for Waste Electronics and Electrical Equipment. It means that used electrical and electronic products should not be mixed with general waste. Used electrical and electronic equipment should be treated separately.

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1 Getting Started

1.1 Overview

The ZyXEL N220 Wireless N-lite USB Adapter brings you a better Internet experience over existing IEEE 802.11 b/g/n networks. With data rates of up to 150 Mbps, you can enjoy a breathtaking high-speed connection at home or in the office. It is an excellent solution for daily activities such as file transfers, music downloading, video streaming and online gaming.

1.1.1 What You Need to Know

The following terms and concepts may help as you read through this section, and subsequently as you read through the rest of the User's Guide.

Access Point

An Access Point (AP) is a network device that acts as a bridge between a wired and a wireless network. Outside of the home or office, APs can most often be found in coffee shops, bookstores and other businesses that offer wireless Internet connectivity to their customers.

Infrastructure

An infrastructure network is one that seamlessly combines both wireless and wired components. One or more APs often serve as the bridge between wireless and wired LANs.

Ad-Hoc

An Ad-Hoc wireless LAN is a self-contained group of computers connected wirelessly and which is independent of any other networks and Access Points.

1.1.2 Before You Begin

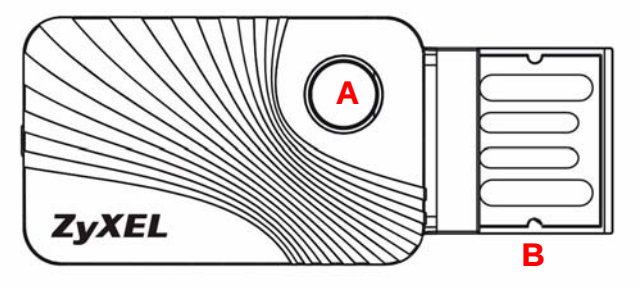
Read the Quick Start Guide for information on making hardware connections and using the ZyXEL utility to connect your N220 to a network.

1.2 Features

Your N220 is an IEEE 802.11n draft 2.0 compliant wireless LAN adapter. It can also connect to IEEE 802.11b/g wireless networks. The N220 is WPS (Wi-Fi Protected Setup) compliant. WPS allows you to easily set up a secure connection with another WPS-enabled device.

The N220 is a USB adapter which connects to an empty USB port on your computer.

Figure 1 The N220



The following table describes the N220.

Table 1 N220 External View

LABEL	DESCRIPTION
A	LED and also a WPS button
B	USB connector

The following table describes the operation of the N220's LEDs.

Table 2 N220 LEDs

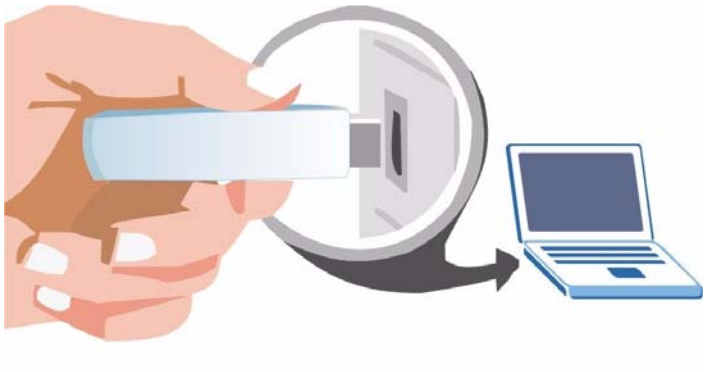
LED	COLOR	STATUS	DESCRIPTION
	Orange	Slow Blinking	The N220 is turned on, connected to an AP, and is not transmitting or receiving data.
		Rapid Blinking	The N220 is turned on, connected to an AP, and is transmitting or receiving data. It also blinks when the WPS feature is being used or a WPS connection is being initiated.
		Off	The N220 is either not connected or the device to which it is connected is turned off.

1.3 Hardware Installation

This sections shows you how to install your N220.

1 Locate an available USB port on the computer.

2 Remove the protective cap to expose the USB connector. Insert the N220 into an available USB port on the computer.



The N220's LED (light) turns on if it is properly inserted.

Note: Never bend, twist or force the N220 into the port. If there is not enough space to attach the N220, use the included USB cable.

1.4 Software Installation

This section shows you how to install the Mac OS X version of the ZyXEL Utility. For detailed information on using it, see Chapter 3 on page 33.

1.4.1 Minimum System Requirements

In order to install the ZyXEL Utility for Mac OS X, your computer must meet the following minimum system requirements:

- 20 MB of free hard drive space
- 128 MB RAM
- Mac OS X 10.3 and higher

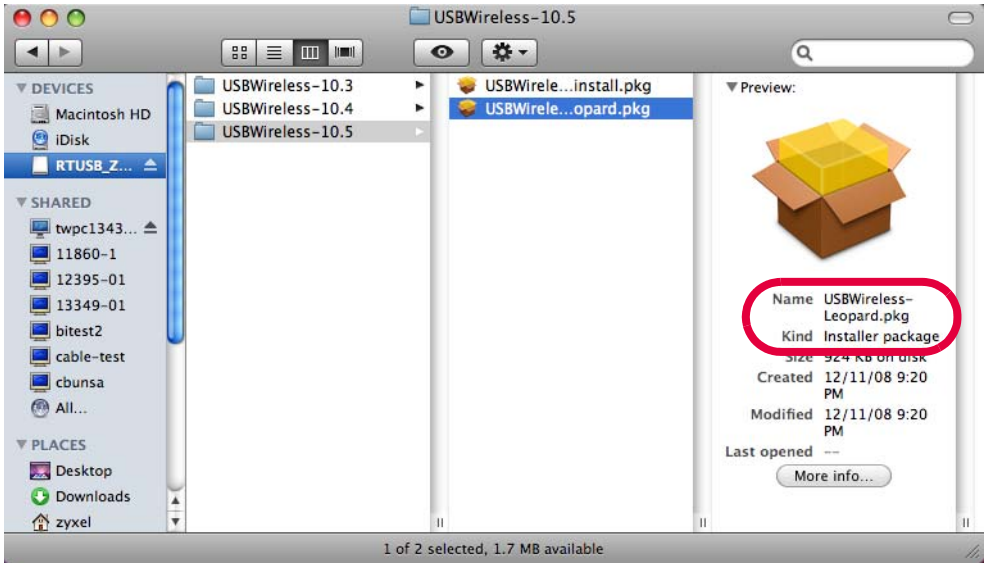
1.4.2 Installing the ZyXEL Utility

To install the ZyXEL Utility:

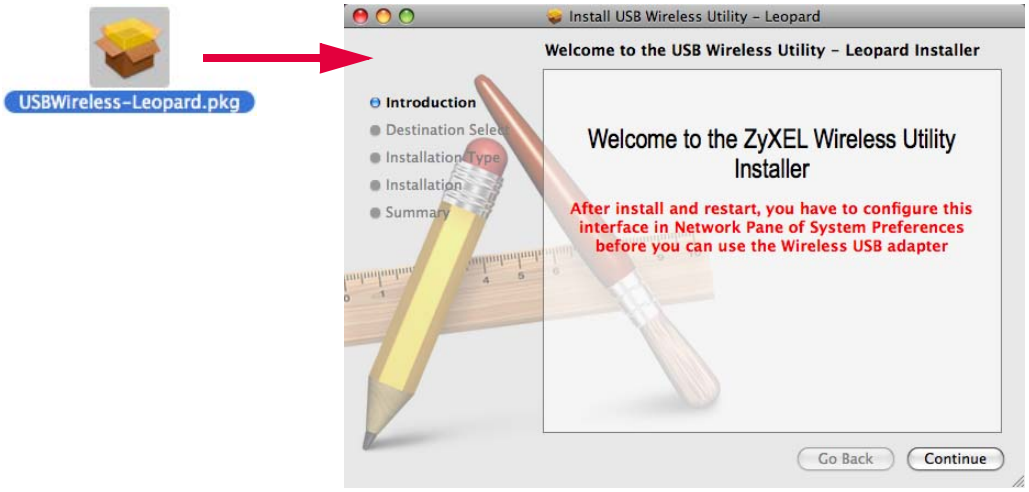
1 Make sure the N220 is disconnected from your computer before you begin the installation process.

2 Open the **ZyXEL_USB.dmg** file on the included disc.

3 Inside the **ZyXEL_USB.dmg**, open the folder for your version of Mac OS X. For example, if you are using 10.5 then open the **USBWireless-10.5** folder.



4 Double-click the **USBWireless-Leopard.pkg** to run the installation program. When it opens, follow the on-screen instructions.


USBWireless-Leopard.pkg
Install USB Wireless Utility – Leopard
Welcome to the USB Wireless Utility – Leopard Installer
Introduction
Destination Select
Installation Type
Installation
Summary
Welcome to the ZyXEL Wireless Utility Installer
After install and restart, you have to configure this interface in Network Pane of System Preferences before you can use the Wireless USB adapter
Go Back
Continue

5 After installing the ZyXEL Utility and device driver, you must restart your computer.

6 Once your computer restarts, you can find the ZyXEL Utility in your **Applications** folder under the name **USBWirelessUtility**.

Note: A second application called the **AwakeZyXELUI.app** is placed in your Applications folder and a link to it is created in your **System Preferences > Accounts > [Admin Account] > Login Items**. This is a monitoring application that detects the N220 whenever you connect it to your computer and which then automatically opens the ZyXEL Utility.

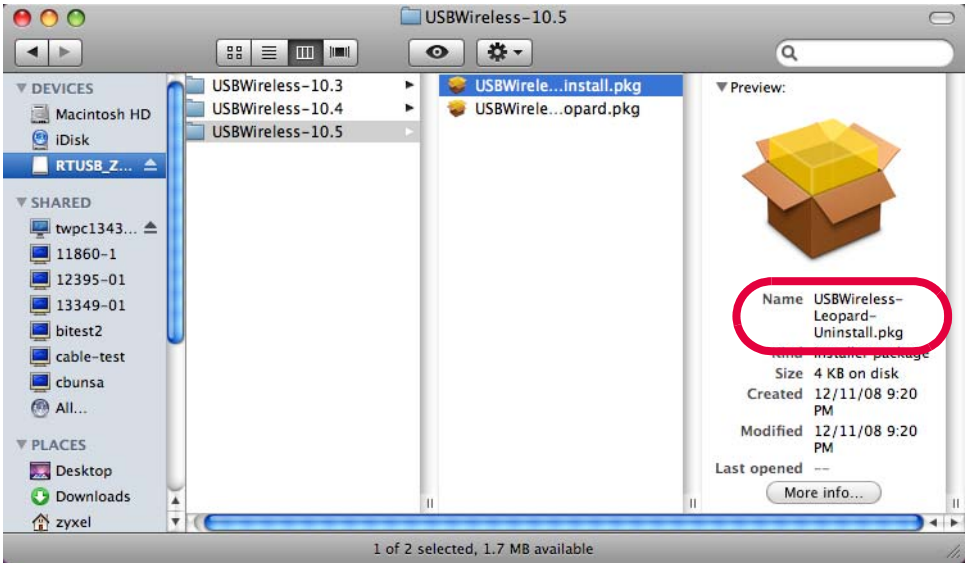
1.4.2.1 Uninstalling the ZyXEL Utility

While you can drag the ZyXEL Utility from your Applications folder directly to the **Trash** and remove it that way, the best and safest course of action is to run the uninstallation program bundled on the included disc. This ensures that all components of the application are properly removed, especially the device driver.

To uninstall the ZyXEL Utility:

1 Open the **ZyXEL_USB.dmg** file on the included disc.

2 Open the folder that corresponds to your version of Mac OS X. For example, if you are using 10.5, then you want to open the **USBWireless-10.5** folder.



3 Double-click the **USBWireless-Leopard-Uninstall.pkg** to run the installation program and follow the on-screen instructions.

4 After uninstalling the ZyXEL Utility and device driver, you must restart your computer.

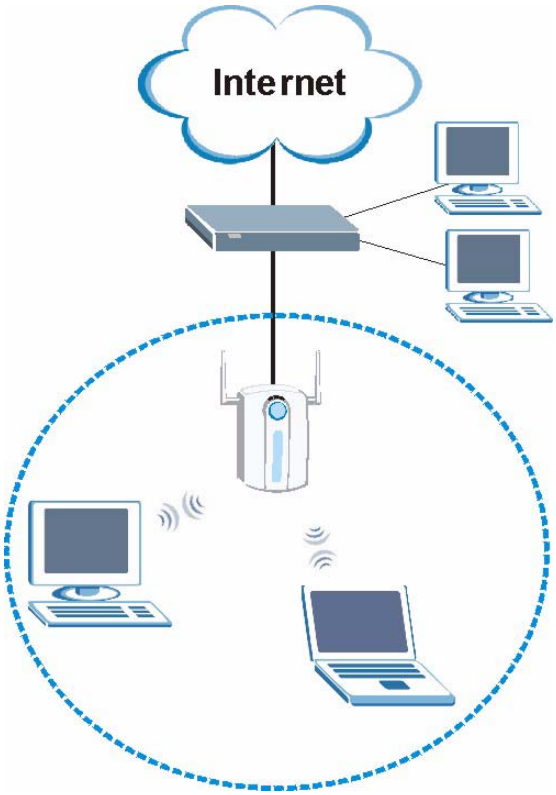
1.5 Device Applications

This section describes some network applications for the N220. You can either set the network type to **Infrastructure** and connect to an AP or use **Ad-Hoc** mode and connect to a peer computer (another wireless device in Ad-Hoc mode).

Infrastructure

To connect to a network via an access point (AP), set the N220 network type to **Infrastructure**. Through the AP, you can access the Internet or the wired network behind it.

Figure 2 Application: Infrastructure



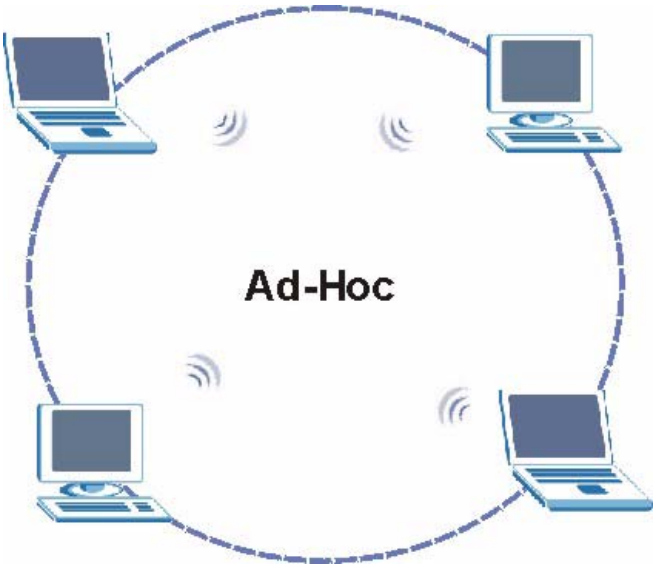
Ad-Hoc

To set up a small independent wireless workgroup without an AP, use **Ad-Hoc**.

Ad-Hoc does not require an AP or a wired network. Two or more wireless clients communicate directly with each other.

Note: Wi-Fi Protected Setup (WPS) is not available in ad-hoc mode.

Figure 3 Application: Ad-Hoc



2

Wireless LANs

2.1 Overview

This section provides background information on wireless Local Area Networks.

2.1.1 What You Can Do in This Section

- Connect securely to an AP using many of the strongest and most common encryption protocols. See Section 2.3 on page 23 for details.
- Connect securely either to an AP or computer-to-computer using WPS. See Section 2.4 on page 25 for details.

2.1.2 What You Need to Know

The following terms and concepts may help as you read through this section.

Server

When two or more devices are connected digitally to form a network, the one that distributes data to the other devices is known as the “server”. A RADIUS (Remote Authentication Dial-In User Service) is a kind of server that manages logins and logout, among other things, for the network to which it is connected.

Client

When two or more devices are connected digitally to form a network, the one that contacts and obtains data from a server is known as the “client”. Each client is designed to work with one or more specific kinds of servers, and each server requires a specific kind of client. Wireless adapters are clients that connect to a network server through an AP.

Authentication

Authentication is the process of confirming a client’s or user’s digital identity when they connect to a network. Turning off authentication means disabling all security protocols and opening your network to anyone with the means to connect to it.

Encryption

The process of taking data and encoding it, usually using a mathematical formula, so that it becomes unreadable unless decrypted with the proper code or pass phrase.

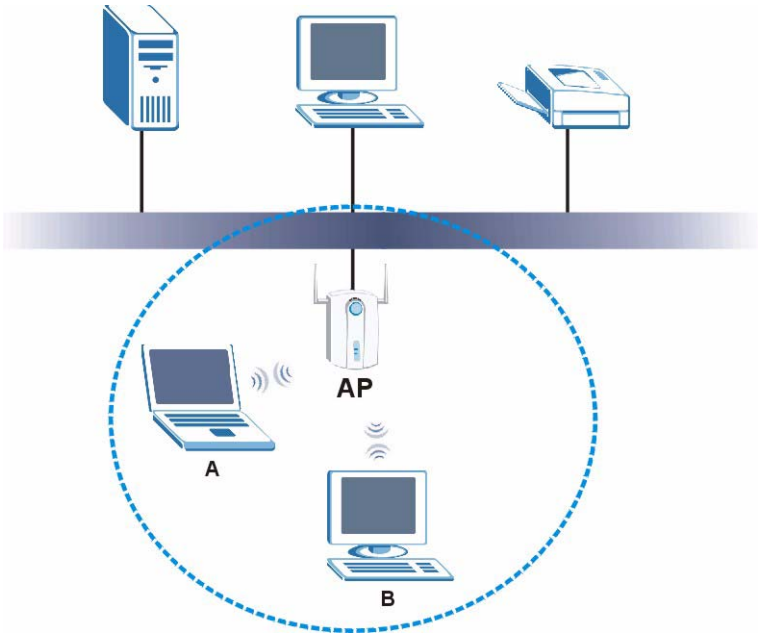
2.1.3 Before You Begin

- You should have valid login information for an existing network Access Point, otherwise you may not be able to make a network connection right away.

2.2 Wireless LAN Overview

The following figure provides an example of a wireless network with an AP. See Figure 3 on page 20 for an Ad Hoc network example.

Figure 4 Example of a Wireless Network



The wireless network is the part in the blue circle. In this wireless network, devices **A** and **B** are called wireless clients. The wireless clients use the access point (AP) to interact with other devices (such as the printer) or with the Internet

Every wireless network must follow these basic guidelines.

- Every device in the same wireless network must use the same SSID.

  The SSID is the name of the wireless network. It stands for Service Set IDentity.

- If two wireless networks overlap, they should use a different channel.

  Like radio stations or television channels, each wireless network uses a specific channel, or frequency, to send and receive information.

- Every device in the same wireless network must use security compatible with the AP or peer computer.

  Security stops unauthorized devices from using the wireless network. It can also protect the information that is sent in the wireless network.

2.3 Wireless LAN Security

Wireless LAN security is vital to your network to protect wireless communications.

If you do not enable any wireless security on your N220, the N220's wireless communications are accessible to any wireless networking device that is in the coverage area.

Note: You can use only WEP encryption if you set the N220 to Ad-hoc mode.

See the appendices for more detailed information about wireless security.

2.3.1 User Authentication and Encryption

You can make every user log in to the wireless network before they can use it. This is called user authentication. However, every wireless client in the wireless network has to support IEEE 802.1x to do this.

Wireless networks can use encryption to protect the information that is sent in the wireless network. Encryption is like a secret code. If you do not know the secret code, you cannot understand the message.

2.3.1.1 WEP

2.3.1.1.1 Data Encryption

WEP (Wired Equivalent Privacy) encryption scrambles all data packets transmitted between the N220 and the AP or other wireless stations to keep network communications private. Both the wireless stations and the access points must use the same WEP key for data encryption and decryption.

There are two ways to create WEP keys in your N220.

- Automatic WEP key generation based on a “password phrase” called a passphrase. The passphrase is case sensitive. You must use the same passphrase for all WLAN adapters with this feature in the same WLAN.

  For WLAN adapters without the passphrase feature, you can still take advantage of this feature by writing down the four automatically generated WEP keys from the **Security Settings** screen of the ZyXEL utility and entering them manually as the WEP keys in the other WLAN adapter(s).

- Enter the WEP keys manually.

  Your N220 allows you to configure up to four 64-bit or 128-bit WEP keys. Only one key is used as the default key at any one time.

2.3.1.1.2 Authentication Type

The IEEE 802.11b/g standard describes a simple authentication method between the wireless stations and AP. Three authentication types are defined: **Auto**, **Open** and **Shared**.

- **Open** mode is implemented for ease-of-use and when security is not an issue. The wireless station and the AP or peer computer do not share a secret key. Thus the wireless stations can associate with any AP or peer computer and listen to any transmitted data that is not encrypted.
- **Shared** mode involves a shared secret key to authenticate the wireless station to the AP or peer computer. This requires you to enable the wireless LAN security and use same settings on both the wireless station and the AP or peer computer.
- **Auto** authentication mode allows the N220 to switch between the open system and shared key modes automatically. Use the auto mode if you do not know the authentication mode of the other wireless stations.

2.3.1.2 IEEE 802.1x

The IEEE 802.1x standard outlines enhanced security methods for both the authentication of wireless stations and encryption key management. Authentication can be done using an external RADIUS server.

2.3.1.2.1 EAP Authentication

EAP (Extensible Authentication Protocol) is an authentication protocol that runs on top of the IEEE 802.1x transport mechanism in order to support multiple types of user authentication. By using EAP to interact with an EAP-compatible RADIUS server, an access point helps a wireless station and a RADIUS server perform authentication.

The type of authentication you use depends on the RADIUS server and an intermediary AP(s) that supports IEEE 802.1x. The N220 supports EAP-TLS, EAP-TTLS (at the time of writing, TTLS is not available in Windows Vista) and EAP-PEAP. Refer to Appendix A on page 61 for descriptions.

For EAP-TLS authentication type, you must first have a wired connection to the network and obtain the certificate(s) from a certificate authority (CA). Certificates (also called digital IDs) can be used to authenticate users and a CA issues certificates and guarantees the identity of each certificate owner.

2.3.1.3 WPA and WPA2

Wi-Fi Protected Access (WPA) is a subset of the IEEE 802.11i standard. WPA2 (IEEE 802.11i) is a wireless security standard that defines stronger encryption, authentication and key management than WPA.

Key differences between WPA(2) and WEP are improved data encryption and user authentication.

Both WPA and WPA2 improve data encryption by using Temporal Key Integrity Protocol (TKIP), Message Integrity Check (MIC) and IEEE 802.1x. WPA and WPA2 use Advanced Encryption Standard (AES) in the Counter mode with Cipher block chaining Message authentication code Protocol (CCMP) to offer stronger encryption than TKIP.

If both an AP and the wireless clients support WPA2 and you have an external RADIUS server, use WPA2 for stronger data encryption. If you don't have an external RADIUS server, you should use WPA2-PSK (WPA2-Pre-Shared Key) that only requires a single (identical) password entered into each access point, wireless gateway and wireless client. As long as the passwords match, a wireless client will be granted access to a WLAN.

If the AP or the wireless clients do not support WPA2, just use WPA or WPA-PSK depending on whether you have an external RADIUS server or not.

Select WEP only when the AP and/or wireless clients do not support WPA or WPA2. WEP is less secure than WPA or WPA2.

2.4 WiFi Protected Setup

Your N220 supports WiFi Protected Setup (WPS), which is an easy way to set up a secure wireless network. WPS is an industry standard specification, defined by the WiFi Alliance.

WPS allows you to quickly set up a wireless network with strong security, without having to configure security settings manually. Each WPS connection works between two devices. Both devices must support WPS (check each device’s documentation to make sure).

Depending on the devices you have, you can either press a button (on the device itself, or in its configuration utility) or enter a PIN (a unique Personal Identification Number that allows one device to authenticate the other) in each of the two devices. When WPS is activated on a device, it has two minutes to find another device that also has WPS activated. Then, the two devices connect and set up a secure network by themselves.

2.4.1 Push Button Configuration

WPS Push Button Configuration (PBC) is initiated by pressing a button on each WPS-enabled device, and allowing them to connect automatically. You do not need to enter any information.

Not every WPS-enabled device has a physical WPS button. Some may have a WPS PBC button in their configuration utilities instead of or in addition to the physical button.

Take the following steps to set up WPS using the button.

1. Ensure that the two devices you want to set up are within wireless range of one another.
2. Look for a WPS button on each device. If the device does not have one, log into its configuration utility and locate the button.
3. Press the button on one of the devices (it doesn't matter which).
4. Within two minutes, press the button on the other device. The registrar sends the network name (SSID) and security key through an secure connection to the enrollee.

   If you need to make sure that WPS worked, check the list of associated wireless clients in the AP's configuration utility. If you see the wireless client in the list, WPS was successful.

2.4.2 PIN Configuration

Each WPS-enabled device has its own PIN (Personal Identification Number). This may either be static (it cannot be changed) or dynamic (in some devices you can generate a new PIN by clicking on a button in the configuration interface).

Use the PIN method instead of the push-button configuration (PBC) method if you want to ensure that the connection is established between the devices you specify, not just the first two devices to activate WPS in range of each other. However, you need to log into the configuration interfaces of both devices to use the PIN method.

When you use the PIN method, you must enter the PIN from one device (usually the wireless client) into the second device (usually the Access Point or wireless router). Then, when WPS is activated on the first device, it presents its PIN to the second device. If the PIN matches, one device sends the network and security information to the other, allowing it to join the network.

Take the following steps to set up a WPS connection between an access point or wireless router (referred to here as the AP) and a client device using the PIN method.

1. Ensure WPS is enabled on both devices.
2. Access the WPS section of the AP's configuration interface. See the device's User's Guide for how to do this.
3. Look for the client's WPS PIN; it will be displayed either on the device, or in the WPS section of the client's configuration interface.
4. Enter the client's PIN in the AP's configuration interface.

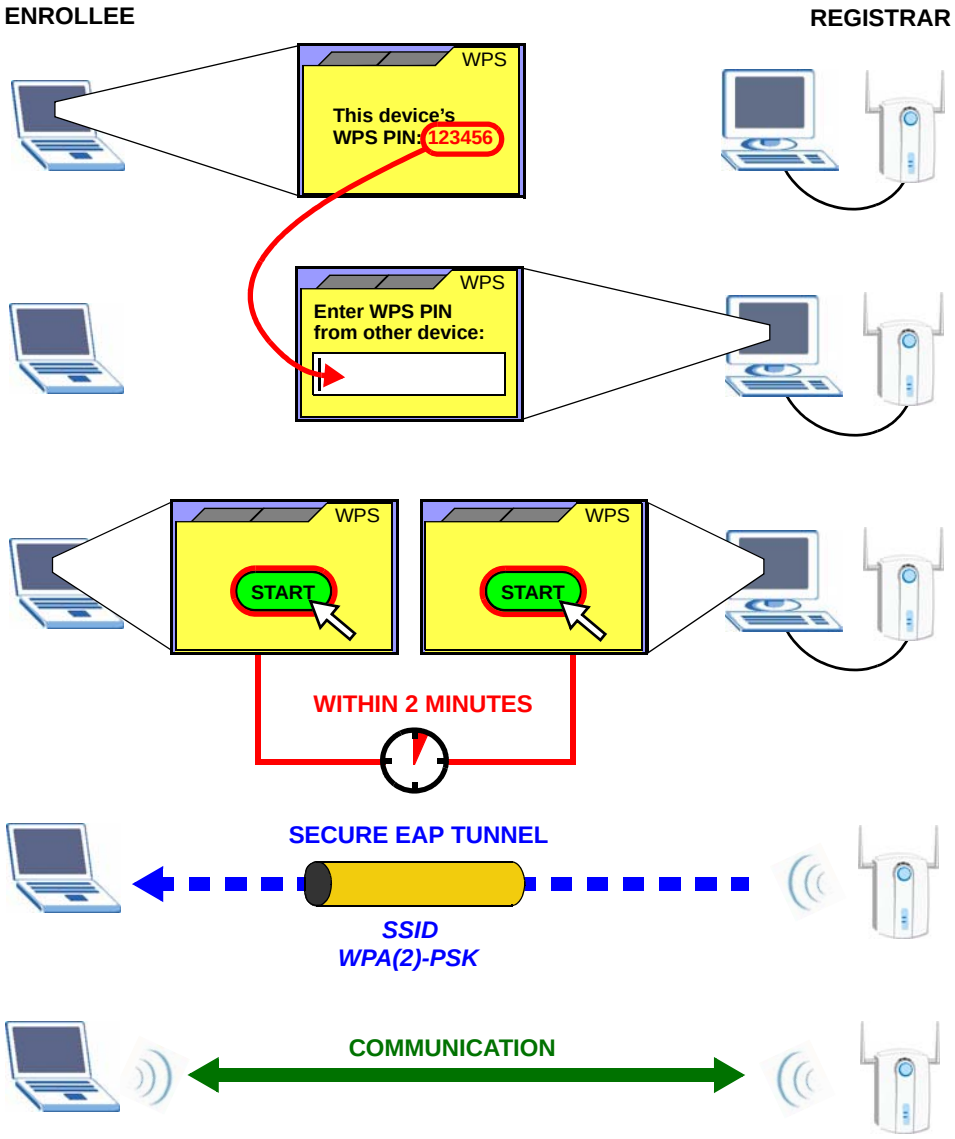
   Note: If the client device's configuration interface has an area for entering another device's PIN, you can either enter the client's PIN in the AP, or enter the AP's PIN in the client - it does not matter which.
5. Start WPS on both devices within two minutes.

   Note: Use the configuration utility to activate WPS, not the push-button on the device itself.
6. On a computer connected to the wireless client, try to connect to the Internet. If you can connect, WPS was successful.

   If you cannot connect, check the list of associated wireless clients in the AP's configuration utility. If you see the wireless client in the list, WPS was successful.

The following figure shows a WPS-enabled wireless client (installed in a notebook computer) connecting to the WPS-enabled AP via the PIN method.

Figure 5 Example WPS Process: PIN Method



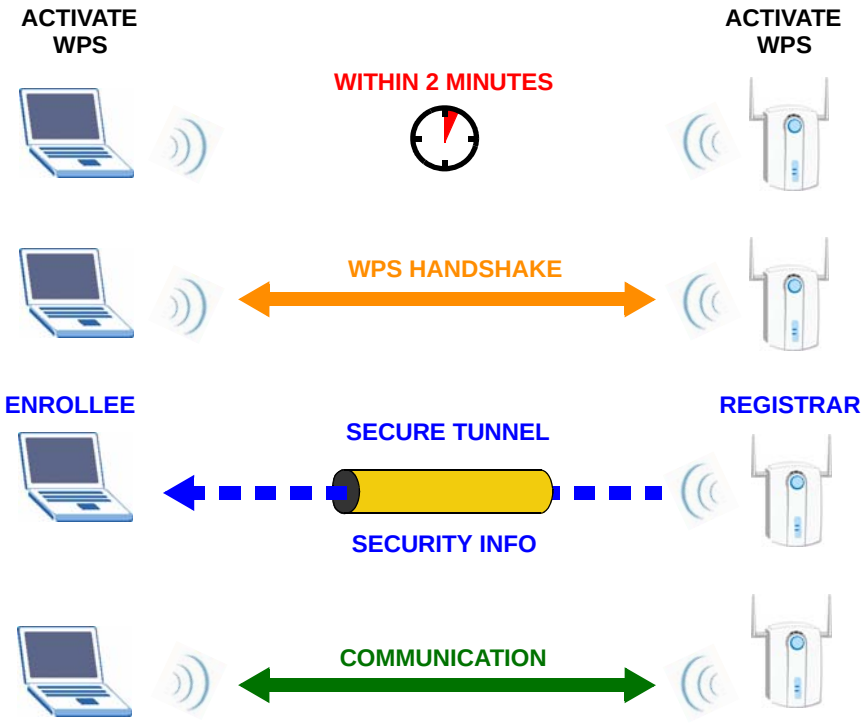
2.4.3 How WPS Works

When two WPS-enabled devices connect, each device must assume a specific role. One device acts as the **Registrar** (the device that supplies network and security settings) and the other device acts as the **Enrollee** (the device that receives network and security settings. The registrar creates a secure EAP (Extensible Authentication Protocol) tunnel and sends the network name (SSID) and the WPA-PSK or WPA2-PSK pre-shared key to the enrollee. Whether WPA-PSK or WPA2-PSK is used depends on the standards supported by the devices. If the registrar is

already part of a network, it sends the existing information. If not, it generates the SSID and WPA(2)-PSK randomly.

The following figure shows a WPS-enabled client (installed in a notebook computer) connecting to a WPS-enabled access point.

Figure 6 How WPS works



The roles of registrar and enrollee last only as long as the WPS setup process is active (two minutes). The next time you use WPS, a different device can be the registrar if necessary.

The WPS connection process is like a handshake; only two devices participate in each WPS transaction. If you want to add more devices you should repeat the process with one of the existing networked devices and the new device.

Note that the access point (AP) is not always the registrar, and the wireless client is not always the enrollee. All WPS-certified APs can be a registrar, and so can some WPS-enabled wireless clients.

By default, a WPS devices is “unconfigured”. This means that it is not part of an existing network and can act as either enrollee or registrar (if it supports both functions). If the registrar is unconfigured, the security settings it transmits to the enrollee are randomly-generated. Once a WPS-enabled device has connected to another device using WPS, it becomes “configured”. A configured wireless client can still act as enrollee or registrar in subsequent WPS connections, but a configured access point can no longer act as enrollee. It will be the registrar in all

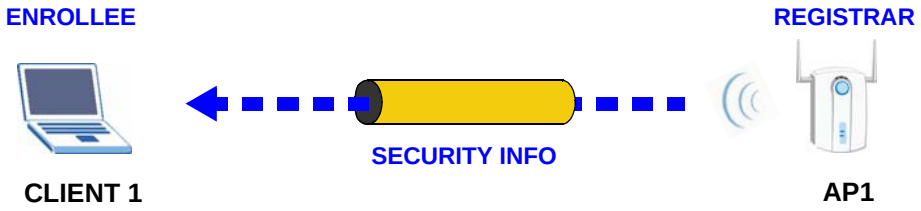
subsequent WPS connections in which it is involved. If you want a configured AP to act as an enrollee, you must reset it to its factory defaults.

2.4.3.1 Example WPS Network Setup

This section shows how security settings are distributed in an example WPS setup.

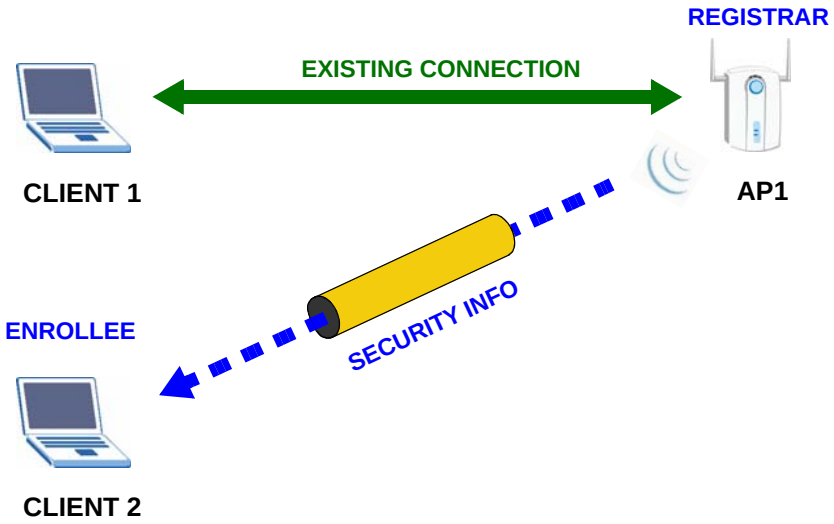
The following figure shows an example network. In step **1**, both **AP1** and **Client 1** are unconfigured. When WPS is activated on both, they perform the handshake. In this example, **AP1** is the registrar, and **Client 1** is the enrollee. The registrar randomly generates the security information to set up the network, since it is unconfigured and has no existing information.

Figure 7 WPS: Example Network Step 1



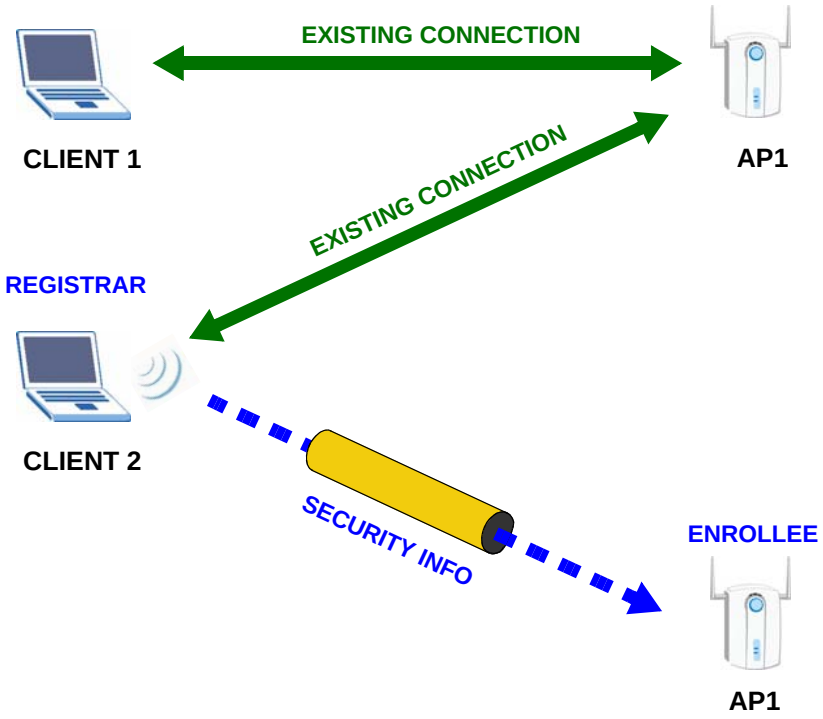
In step **2**, you add another wireless client to the network. You know that **Client 1** supports registrar mode, but it is better to use **AP1** for the WPS handshake with the new client since you must connect to the access point anyway in order to use the network. In this case, **AP1** must be the registrar, since it is configured (it already has security information for the network). **AP1** supplies the existing security information to **Client 2**.

Figure 8 WPS: Example Network Step 2



In step 3, you add another access point (**AP2**) to your network. **AP2** is out of range of **AP1**, so you cannot use **AP1** for the WPS handshake with the new access point. However, you know that **Client 2** supports the registrar function, so you use it to perform the WPS handshake instead.

Figure 9 WPS: Example Network Step 3



2.4.4 Limitations of WPS

WPS has some limitations of which you should be aware.

- WPS works in Infrastructure networks only (where an AP and a wireless client communicate). It does not work in Ad-Hoc networks (where there is no AP).
- When you use WPS, it works between two devices only. You cannot enroll multiple devices simultaneously, you must enroll one after the other.

  For instance, if you have two enrollees and one registrar you must set up the first enrollee (by pressing the WPS button on the registrar and the first enrollee, for example), then check that it successfully enrolled, then set up the second device in the same way.

- WPS works only with other WPS-enabled devices. However, you can still add non-WPS devices to a network you already set up using WPS.

  WPS works by automatically issuing a randomly-generated WPA-PSK or WPA2-PSK pre-shared key from the registrar device to the enrollee devices. Whether the network uses WPA-PSK or WPA2-PSK depends on the device. You can check the configuration interface of the registrar device to discover the key the network is using (if the device supports this feature). Then, you can enter the key into the non-WPS device and join the network as normal (the non-WPS device must also support WPA-PSK or WPA2-PSK).

- When you use the PBC method, there is a short period (from the moment you press the button on one device to the moment you press the button on the other device) when any WPS-enabled device could join the network. This is because the registrar has no way of identifying the “correct” enrollee, and cannot differentiate between your enrollee and a rogue device. This is a possible way for a hacker to gain access to a network.

  You can easily check to see if this has happened. WPS works between only two devices simultaneously, so if another device has enrolled your device will be unable to enroll, and will not have access to the network. If this happens, open the access point’s configuration interface and look at the list of associated clients (usually displayed by MAC address). It does not matter if the access point is the WPS registrar, the enrollee, or was not involved in the WPS handshake; a rogue device must still associate with the access point to gain access to the network. Check the MAC addresses of your wireless clients (usually printed on a label on the bottom of the device). If there is an unknown MAC address you can remove it or reset the AP.

3

ZyXEL Utility - Mac OS X

3.1 Overview

This chapter shows you how to use the ZyXEL utility to configure your N220 using the Macintosh operating system, Mac OS X.

3.1.1 What You Can Do in This Chapter

- The **Profile** screen (Section 3.3 on page 35) lets you create, delete and manage your wireless network profiles.
- The **Link Status** screen (Section 3.6 on page 40) lets you see your current connection details, monitor signal strength and quality, and more.
- The **Site Survey** screen (Section 3.7 on page 41) lets you connect to any available unsecured wireless network in range of the N220, or open the security settings screen for any secured wireless network in range.
- The **Statistics** screen (Section 3.8 on page 43) lets you view network traffic statistics between the N220 and the AP or peer to which it is connected.
- The **Advanced** screen (Section 3.9 on page 45) lets you configure your N220 with advanced hardware options.
- The **WPS** screen (Section 3.10 on page 46) lets you configure your N220's Wi-Fi Protected Setup (WPS) options as well as establish and manage WPS connections.
- The **About** screen (Section 3.11 on page 50) lets you view the information about which version of the driver and utility you are currently using.

3.1.2 What You Need to Know

The following terms and concepts may help as you read through this chapter.

Wired Equivalent Privacy (WEP)

Although one of the original wireless encryption protocols, WEP is also the weakest. Many people use it strictly to deter unintentional usage of their wireless network by outsiders.

Wi-Fi Protected Access (WPA)

The WPA protocol affords users with vastly stronger security than WEP. It comes in two different varieties: WPA and WPA2. Always try to use WPA2 as it implements the full version of the security standard and WPA does not.

Pre-Shared Key (PSK)

A pre-shared key is a password shared between the server and the client that unlocks the algorithm used to encrypt the data traffic between them. Without the proper password, the client and the server cannot communicate.

Extensible Authentication Protocol (EAP)

An enhanced security framework designed to improve an existing security protocol, such as WPA-PSK or WPA2-PSK.

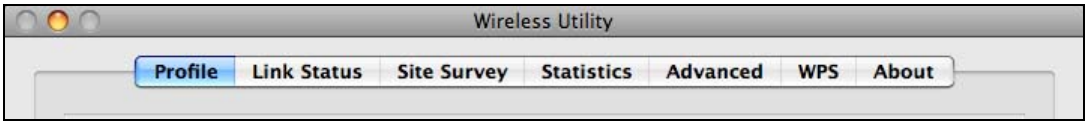
3.1.3 Before You Begin

- Make sure the Mac OS X version of the ZyXEL utility is already installed on your computer. See Section 1.4 on page 15 for more information.
- After installation, make sure you repair permissions on your installation drive. Click **Applications > Utilities > Disk Utility** or do a Spotlight search for the key words “Disk Utility” and select it from the search results list. When the Disk Utility application opens, select your installation drive and then click the **Repair Permissions** button.

3.2 ZyXEL Utility Screen Summary

This section describes the ZyXEL utility screens in Mac OS X.

Figure 10 ZyXEL Utility: ZyXEL Utility Menu Summary



The following table describes the menus.

Table 3 ZyXEL Utility: Menu Summary

TAB	DESCRIPTION
Profile	Use this screen to add, delete, edit or activate a profile with a set of wireless and security settings.
Link Status	Use this screen to see your current connection status, configuration and data rate statistics.

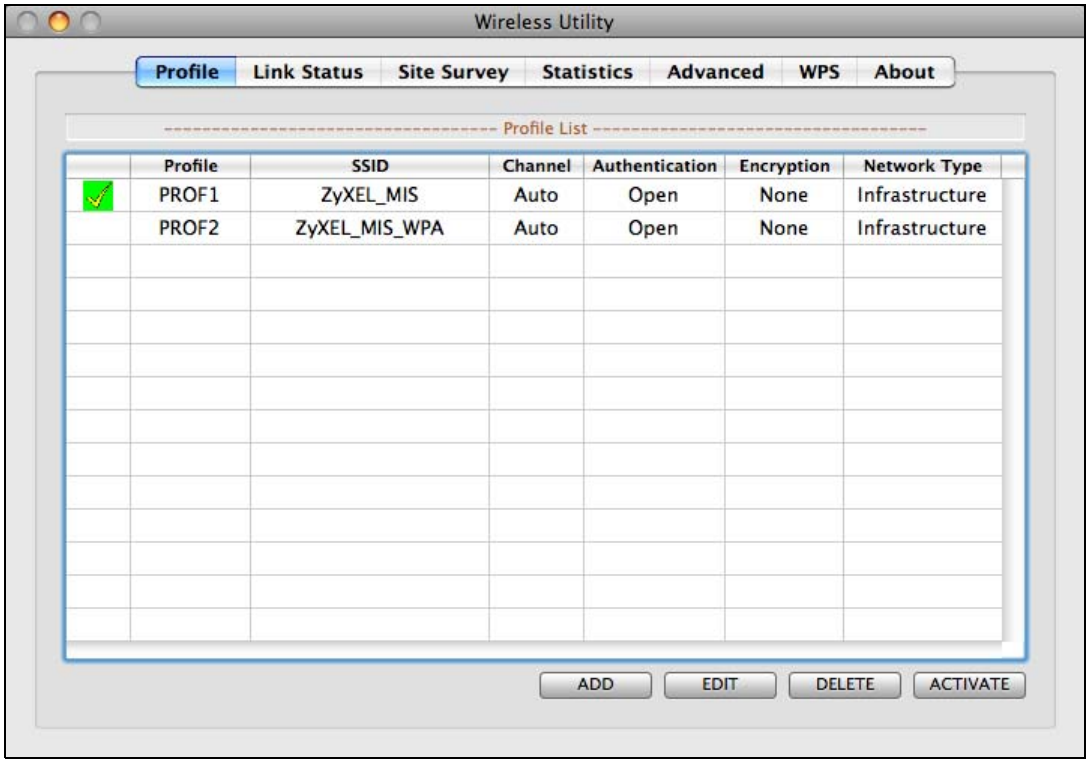
Table 3 ZyXEL Utility: Menu Summary

TAB	DESCRIPTION
Site Survey	Use this screen to: • scan for a wireless network • configure wireless security (if activated on the selected network) • connect to a wireless network
Statistics	Use this screen to view advanced information on wireless network traffic.
Advanced	Use this screen to configure advanced settings on your N220.
WPS	Use this screen to configure the WPS (Wi-Fi Protected Security) settings on your N220.
About	Use this screen to find the utility and driver version.

3.3 The Profile Screen

This screen allows you to configure and manage wireless profiles.

Figure 11 ZyXEL Utility: Profile



The following table describes the labels in this screen.

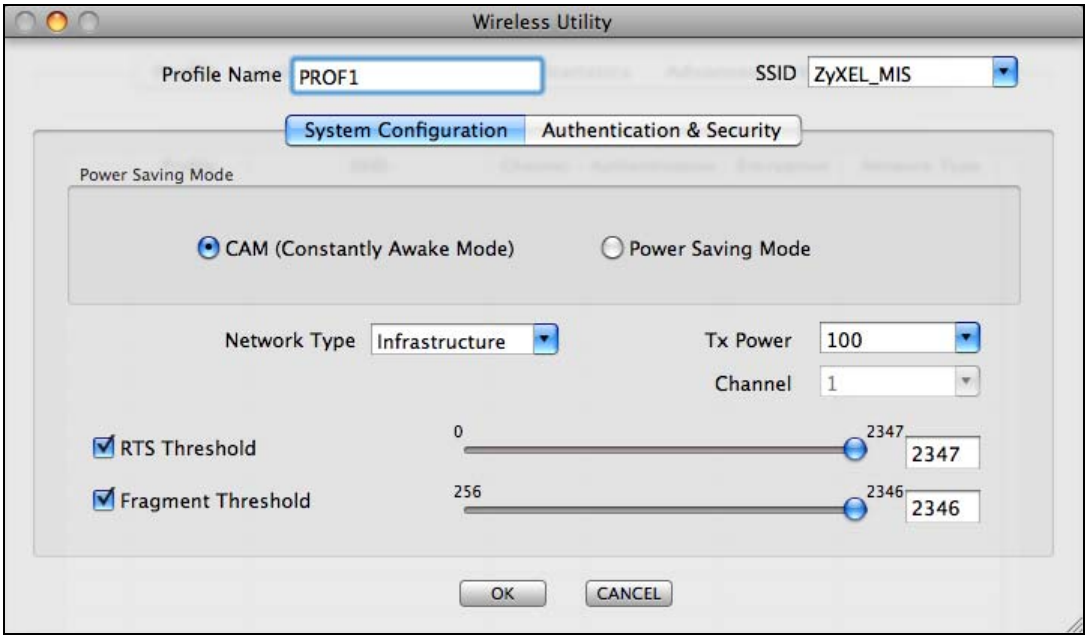
Table 4 ZyXEL Utility: Profile

LABEL	DESCRIPTION
	This icon indicates the currently active profile.
Profile	This is the name of the pre-configured profile.
SSID	This is the SSID of the wireless network to which the selected profile associates.
Channel	This field displays the channel number used by the profile.
Authentication	This field displays the type of authentication used by the profile (**Open**, **Shared**, **WPA-PSK** or **WPA2-PSK**).
Encryption	This field displays the encryption protocol used by the profile. • When WEP security is used, **WEP** displays. • When WPA-PSK or WPA2-PSK security is used, **TKIP** or **AES** displays.
Network Type	This field displays **Infrastructure** when the profile is configured to connect to an access point, or **Ad Hoc** when the profile is configured to connect to another computer.
Add	Click this to create a new profile.
Edit	Click this to alter the settings of a selected profile.
Delete	Click this to remove a selected profile from the list.
Activate	Click this to select the profile to use. Alternatively, double-click the profile's name in the list.

3.4 The Profile - System Configuration Screen

This screen allows you to configure system and network settings for your N220.

Figure 12 ZyXEL Utility: Profile - System Configuration



The following table describes the labels in this screen.

Table 5 ZyXEL Utility: Profile - System Configuration

LABEL	DESCRIPTION
Profile Name	Enter a descriptive name in this field, or alternatively keep the name assigned by the utility.
SSID	Select an available wireless device from the list, or enter the SSID of the wireless device to which you want to associate.
CAM (Constantly Awake Mode)	Select this to have the N220 never go into sleep mode.
Power Saving Mode	Select this to have the N220 go into sleep mode when it is not transmitting data.
Network Type	Select **Infrastructure** to connect to a wireless access point, or select **802.11 Ad Hoc** to connect to another wireless-enabled computer.
Tx Power	This field controls the transmission power of the N220. When using the N220 with a notebook computer, select a lower transmission power level when you are close to the AP in order to conserve battery power.
Channel	In ad-hoc mode, choose the radio channel to use for the wireless network. If there are other networks in the area, choose a channel as far away as possible, in order to minimize the risk of interference. In Infrastructure mode, this field is not configurable; the N220 uses whichever channel the AP uses.

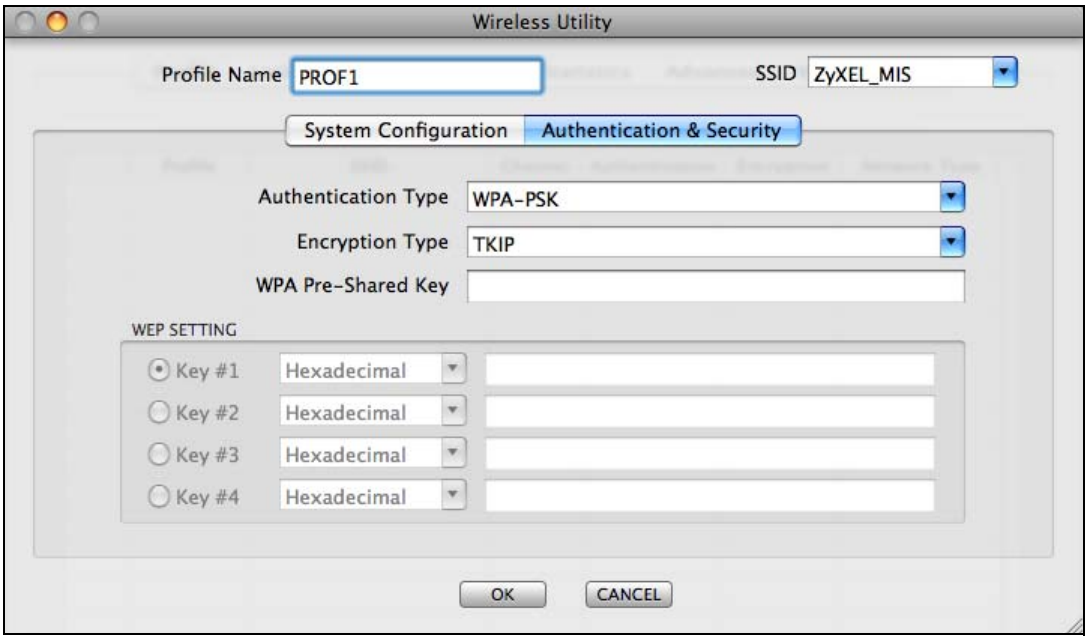
Table 5 ZyXEL Utility: Profile - System Configuration (continued)

LABEL	DESCRIPTION
RTS Threshold	Select the packet size above which the N220 transmits an RTS (Request To Send) message.
Fragment Threshold	Select the packet size above which the N220 fragments (breaks up) the packet into smaller pieces.
OK	Click this to save your changes and return to the **Profile List** screen.
Cancel	Click this to return to the **Profile List** screen without saving your changes.

3.5 The Profile - Authentication and Security Screen

This screen allows you to configure security settings on your N220.

Figure 13 ZyXEL Utility: Profile - Authentication and Security



The following table describes the labels in this screen.

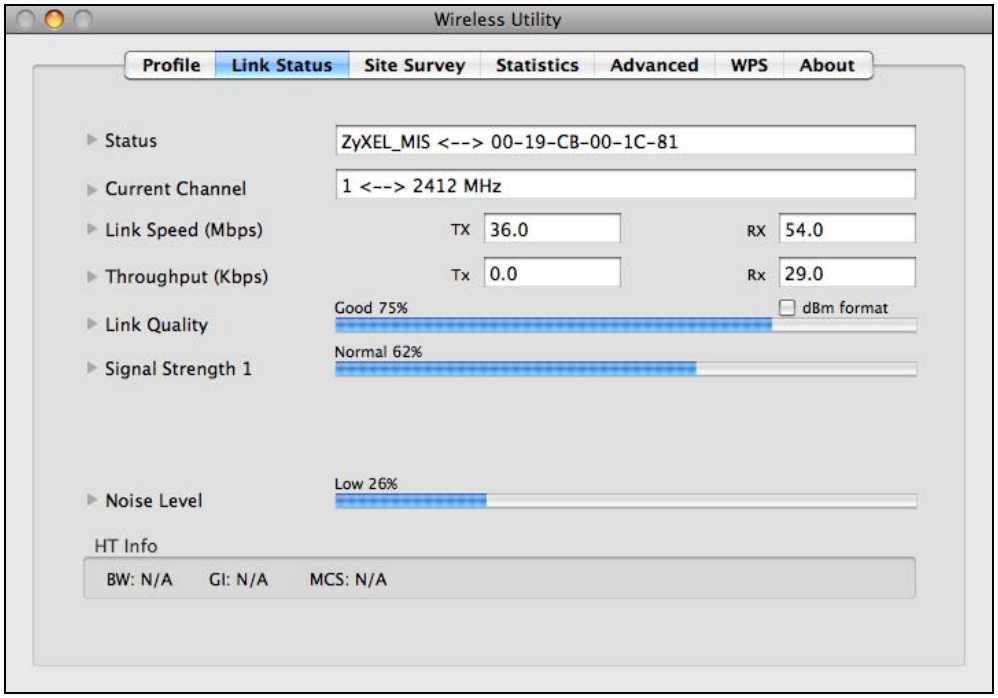
Table 6 ZyXEL Utility: Profile - Authentication and Security

LABEL	DESCRIPTION
Authentication Type	Select the security standard you want to use. All the other wireless devices on your network must be able to use the same standard you select. • **Open** mode is used when security is not an issue. No authentication is required, and any wireless device can join the network. • **Shared** mode security is used with WEP (Wired Equivalent Privacy). • **WPA-PSK** security uses a pre-shared key. All the wireless devices on the network use the same key to access the network. This option is not available in ad-hoc mode. • **WPA2-PSK** is an improved version of WPA-PSK security. This option is not available in ad-hoc mode.
Encryption Type	• When you select **Open** in the **Authentication Type** field, either select **NONE** to use no security (Open), or select **WEP** to use Wired Equivalent Privacy security (Shared) for data encryption. • When you select **Shared** in the **Authentication Type** field, this displays **WEP** and the N220 uses Wired Equivalent Privacy security for data encryption. • When you select **WPA-PSK** or **WPA2-PSK** in the **Authentication Type** field, select **TKIP** to use the Temporal Key Integrity Protocol. Alternatively, select **AES** to use the Advanced Encryption Standard.
WPA Pre-Shared Key	When you select **WPA-PSK** or **WPA2-PSK** in the **Authentication Type** field, enter the network's pre-shared key (8~64 uppercase or lowercase letters and numbers).
Key #1~4	When you select **WEP** in the **Encryption Type** field, you must enter the network's WEP key. Check with your network's administrator for the correct settings. Select the key number (**1**~**4**), select the key type (**Hexadecimal** or **ASCII**), and enter the WEP key in the field to the right. Hexadecimal keys use numerals and the letters a~f only, whereas ASCII keys use numerals and all letters.
OK	Click this to save your settings and return to the previous screen.
Cancel	Click this to return to the previous screen without saving your settings.

3.6 The Link Status Screen

This screen allows you to view the status of the N220's wireless connection with an AP or peer computer.

Figure 14 ZyXEL Utility: Link Status



The following table describes the labels in this screen.

Table 7 ZyXEL Utility: Link Status

LABEL	DESCRIPTION
Status	This displays the SSID (Service Set IDentifier) and MAC (Media Access Control) address of the access point or peer device to which the N220 is connected.
Current Channel	This displays the channel number of the current wireless connection, as well as the radio frequency of the channel in megahertz.
Link Speed (Mbps)	This displays the maximum possible data transmission (**Tx**) and reception (**Rx**) speeds of the current connection in megabits per second.
Throughput (Kbps)	This displays the actual data transmission (**Tx**) and reception (**Rx**) speeds of the current connection in kilobits per second.
Link Quality	This shows the quality of the wireless connection. This refers to the percentage of packets transmitted successfully. If there are too many wireless stations in a wireless network, collisions may occur which could result in a loss of messages even though you have high signal strength.
dBm format	Select this option to display the Link Quality as a power ratio in decibels (dBm) rather than as a percentage.

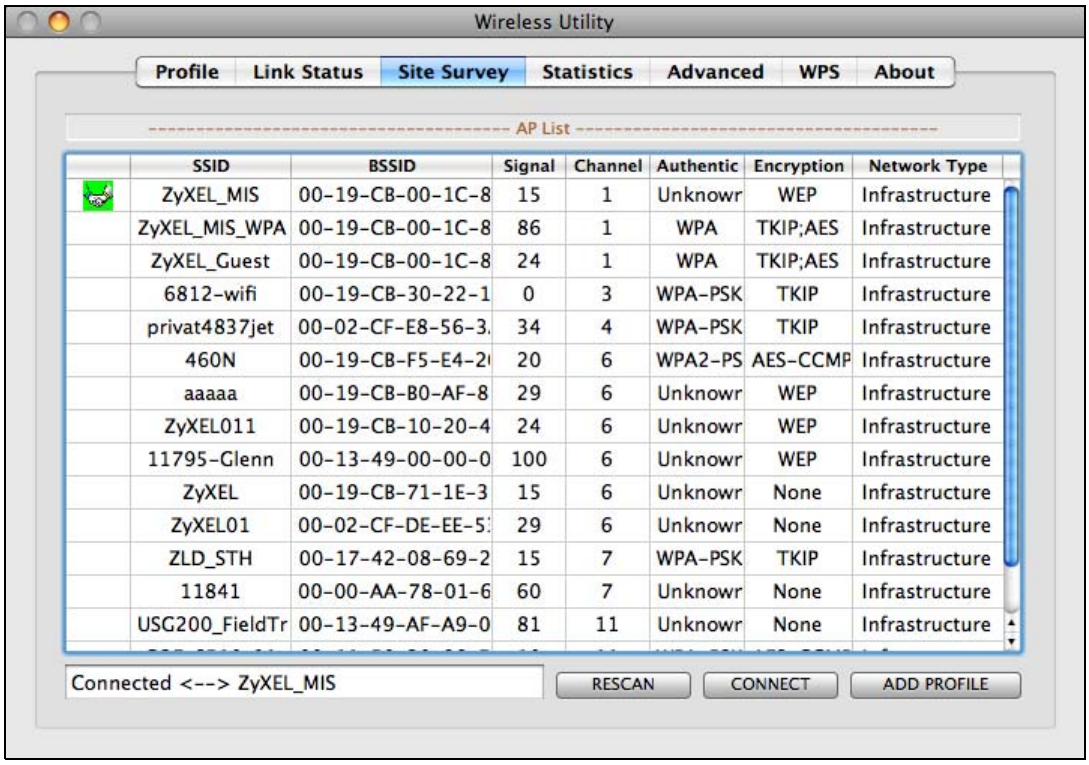
Table 7 ZyXEL Utility: Link Status (continued)

LABEL	DESCRIPTION
Signal Strength 1	This shows the strength of the antenna's signal. The signal strength depends mainly on the antenna output power and the distance between your N220 and the AP or peer computer.
Noise Level	This indicates the relative interfence from other nearby wireless devices as a percentage. The higher the percentage, the greater the interference.
HT Info	This section displays wireless technical data, such Bandwidth (**BW**) frequency, Guard Interval (**GI**), and Modulation and Coding Scheme (**MCS**). It is not user configurable and is only used for customer service troubleshooting.

3.7 The Site Survey Screen

This screen allows you to view available networks and connect to a network.

Figure 15 ZyXEL Utility: Site Survey



The following table describes the labels in this screen.

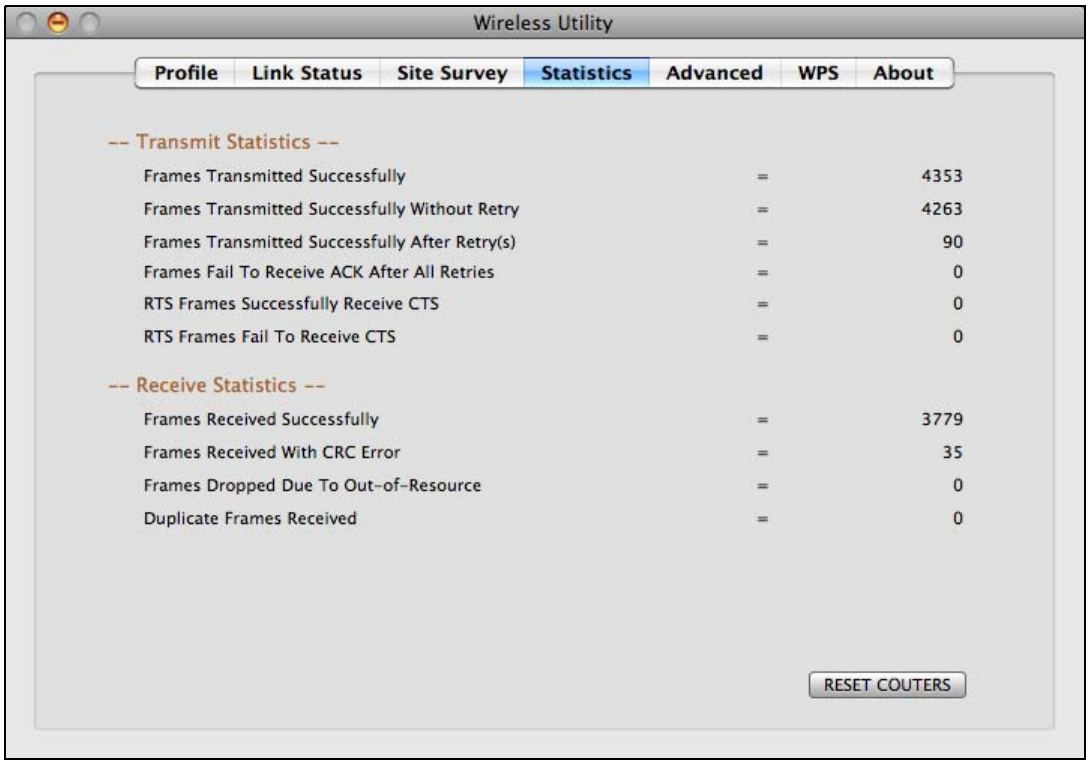
Table 8 ZyXEL Utility: Site Survey

LABEL	DESCRIPTION
	This indicates a connection to the associated AP.
SSID	This displays the network's Service Set IDentifier. The SSID is the name of the network.
BSSID	This displays the Basic Service Set IDentifier. The BSSID is the MAC (Media Access Control) address of the access point or peer wireless device. Every networking device has a unique MAC address, which identifies it on the network.
Signal	This displays the received radio signal strength of the network. The higher the value, the better the connection.
Channel	This displays the wireless channel on which the network is operating.
Authentication	This displays whether **WPA**, **WPA2**, **WPA-PSK** or **WPA2-PSK** is used on the network. If the network uses no security or WEP, **Unknown** displays.
Encryption	• When WPA, WPA2, WPA-PSK or WPA2-PSK is used, this displays the encryption protocol used (**TKIP** or **AES**). • When WEP is used, **WEP** displays. • When no security is used, **None** displays.
Network Type	This field displays the network type (**Infrastructure** or **Ad Hoc**) of the wireless device.
RESCAN	Click this to update the list.
CONNECT	Click this to connect to the highlighted wireless network.
ADD PROFILE	Click this to go to the **Add Profile: System Configuration** screen.

3.8 The Statistics Screen

This screen allows you to view statistics on network traffic between the N220 and the associated AP or peer computer. This screen is primarily for troubleshooting purposes.

Figure 16 ZyXEL Utility: Statistics


Wireless Utility
Profile
Link Status
Site Survey
Statistics
Advanced
WPS
About
-- Transmit Statistics --
Frames Transmitted Successfully = 4353
Frames Transmitted Successfully Without Retry = 4263
Frames Transmitted Successfully After Retry(s) = 90
Frames Fail To Receive ACK After All Retries = 0
RTS Frames Successfully Receive CTS = 0
RTS Frames Fail To Receive CTS = 0
-- Receive Statistics --
Frames Received Successfully = 3779
Frames Received With CRC Error = 35
Frames Dropped Due To Out-of-Resource = 0
Duplicate Frames Received = 0
RESET COUTERS

The following table describes the labels in this screen.

Table 9 ZyXEL Utility: Statistics

LABEL	DESCRIPTION
Transmit Statistics	This section displays statistics about the data frames sent by the N220.
Frames Transmitted Successfully	This displays the total number of frames transmitted by the N220.
Frames Transmitted Successfully Without Retry	This displays the number of frames successfully transmitted by the N220 on the first attempt.
Frames Transmitted Successfully After Retry(s)	This displays the number of frames transmitted by the N220 after a second or subsequent attempt.

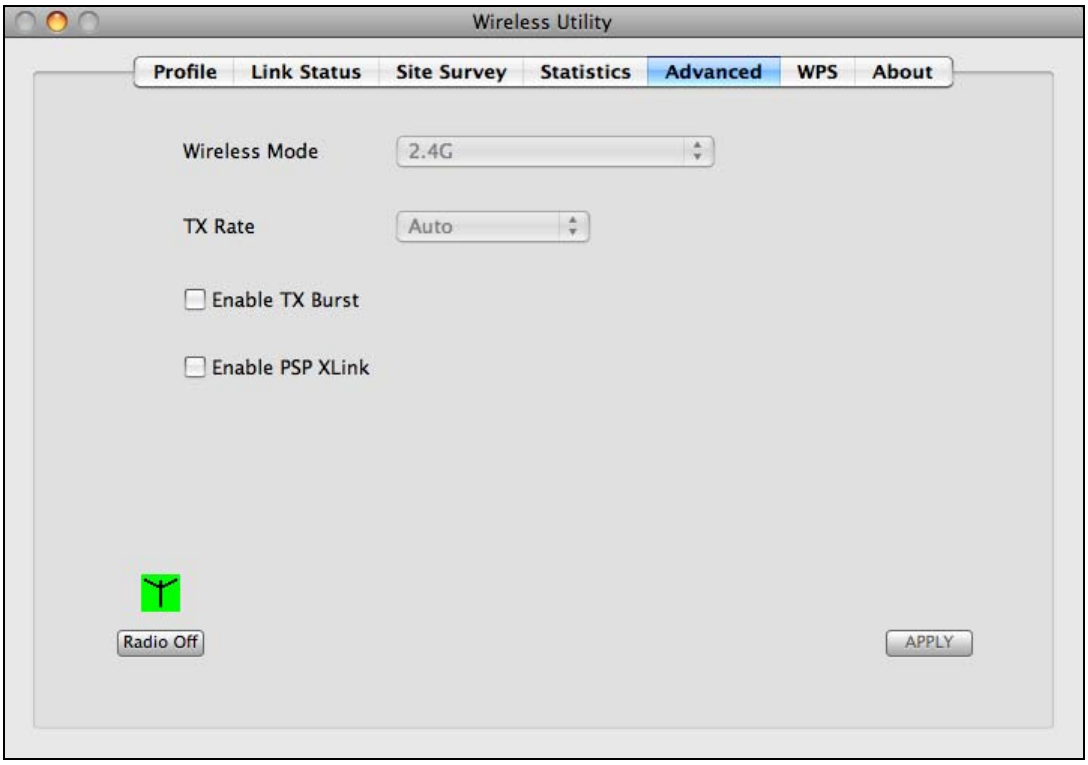
Table 9 ZyXEL Utility: Statistics (continued)

LABEL	DESCRIPTION
Frames Failed to Receive ACK After All Retries	This displays the number of frames transmitted by the N220 that did not receive an acknowledgement response from the other wireless device.
RTS Frames Successfully Received CTS	This displays the number of frames, large enough to require the sending of a “Request to Send” message, that then received a “Clear to Send” message from the other wireless device.
RTS Frames Failed to Receive CTS	This displays the number of frames, large enough to require the sending of a “Request to Send” message, that did not receive a “Clear to Send” message from the other wireless device.
Receive Statistics	This section displays statistics about the data frames received by the N220.
Frames Received Successfully	This displays the number of frames received by the N220 without error.
Frames Received with CRC Error	This displays the number of frames received by the N220 that contained a Cyclic Redundancy Check error. Cyclic Redundancy Checks are used to determine whether received data has been altered in transit (by radio interference, for example).
Frames Dropped Due To Out-of-Resource	This displays the number of frames that were not processed because the N220 did not have the necessary memory.
Duplicate Frames Received	This shows the number of received frames that were identical to other received frames.
RESET COUNTERS	Click this to turn all the counters back to zero.

3.9 The Advanced Screen

This screen allows you to configure advanced network settings on your N220.

Figure 17 ZyXEL Utility: Advanced



The following table describes the labels in this screen.

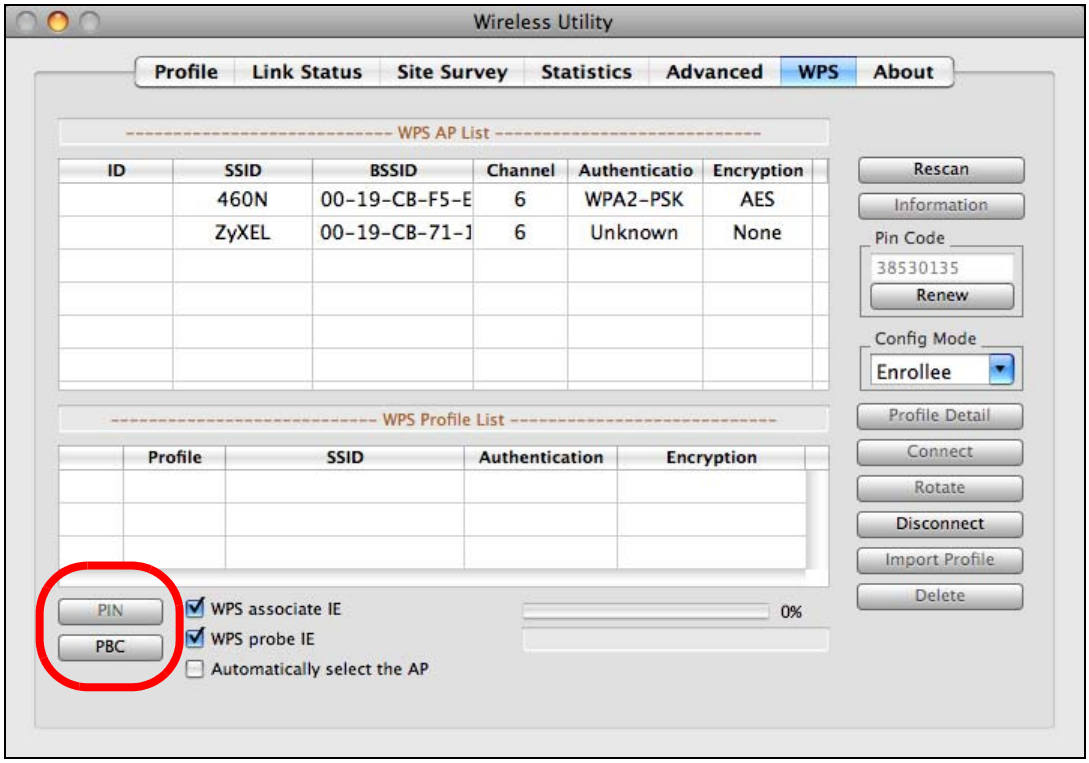
Table 10 ZyXEL Utility: Advanced

LABEL	DESCRIPTION
Wireless Mode	This indicates the N220's wireless network mode.
TX Rate	This field displays the maximum rate at which data is sent by the N220 over the wireless network. **Auto** indicates that the network speed is chosen automatically by the N220 based on its current connection.
Enable TX Burst	Select this to turn burst transmission on. Deselect it to turn burst transmission off.
Enable PSP XLink	Select this to allow ad-hoc network building with the PSP KAI game server.
Radio On/Off	A green icon ( ) displays when the N220's radio is enabled. A red icon ( ) displays when the N220's radio is disabled. Click **Radio Off** to disable the N220's wireless functions. Click **Radio On** to enable the N220's wireless functions.
Apply	Click this to save your settings.

3.10 The WPS Screen

This screen allows you to configure the N220's Wi-Fi Protected Security (WPS).

Figure 18 ZyXEL Utility: WPS



The following table describes the labels in this screen.

Table 11 ZyXEL Utility: WPS

LABEL	DESCRIPTION
WPS AP List	This displays a list of WPS-compatible devices within range of the N220.
ID	This field indicates the AP's identication number, if it has one.
SSID	This field indicates the AP's Service Set Identification (SSID)
BSSID	This field indicates the AP's Basic Service Set Identification (BSSID)
Channel	This field indicates the channel on which the AP is broadcasting.
Authenticati on	This field indicates the type of authentication required by the AP.
Encryption	This field indicates the type of encryption used by the AP.
WPS Profile List	This section displays a profile created explicitly for use with WPS in **Registrar** mode. The N220 creates the profile on the fly as it is needed. When in **Enrollee** mode, this section displays connection profile settings.
Profile	This field indicates the profile name. Profiles created on the fly are named **Profile#** where # is a number. For example, Profile1.
SSID	This field indicates your profile's unique SSID.

Table 11 ZyXEL Utility: WPS (continued)

LABEL	DESCRIPTION
Authentication	This field indicates the authentication type required by your N220 while using WPS.
Encryption	This field indicates the encryption required by your N220 while using WPS.
Rescan	Click this button to rescan the local area for WPS-compatible devices.
Information	Select an AP from the **WPS AP List** and then click this button to display detailed information on it. See Section 3.10.1 on page 48 for more details.
PIN Code	This field displays a randomly generated 8-digit personal identification code for your N220. In **Enrollee** mode it is not editable but it can be renewed; in **Registrar** mode it can be edited. Click the **Renew** button to randomly generate a new PIN code.
Config Mode	Select either **Enrollee** or **Registrar**. As a WPS enrollee, your device can make basic WPS connections with minimal configuration. As a WPS registrar you can set your device to store all your connection information as a profile, which you can later use again by activating it on the **Profile** screen. By default, we suggest that you keep the device in **Enrollee** mode.
Profile Detail	Select a profile from the **WPS Profile List**, then click this button to view detailed information about it. See Section 3.10.2 on page 49 for more information.
Connect	Select a profile from the **WPS Profile List**, then click this button to make a connection using the previously saved settings associated with the profile.
Rotate	At the time of writing, this feature is not enabled.
Disconnect	Press this button to disconnect from the network represented by the currently active profile.
Import Profile	Click this button to save any profile that has been created on the fly for the purposes of making a WPS connection. Your profile is saved in the **Profile** screen.
Delete	At the time of writing, this feature is not enabled.
PIN	Click this button to make a PIN-based WPS connection. For details, see Section 2.4.2 on page 26. Note: For most WPS connections, this button or the PBC button are all you need.
PBC	Click this button to make a PBC-based WPS connection. For details, see Section 2.4.1 on page 26. Note: For most WPS connections, this button or the PIN button are all you need.

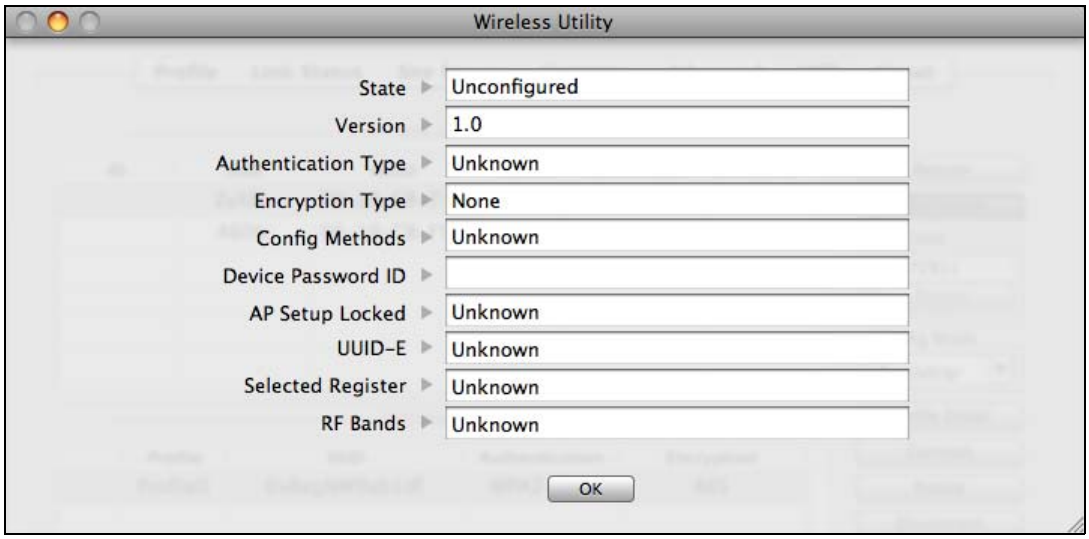
Table 11 ZyXEL Utility: WPS (continued)

LABEL	DESCRIPTION
WPS associate IE	Sends the association request with WPS IE during WPS. Note: Leave this option selected at all times to ensure a stable connection.
WPS probe IE	Sends the probe request with WPS IE during WPS. Note: Leave this option selected at all times to ensure a stable connection.
Automatically select the AP	Select this option to have the N220 automatically scan for and then select a WPS-compatible AP while making a WPS connection.

3.10.1 The Information Screen

While in the WPS screen, you can view information about any AP in the **WPS AP List**. Click the **Information** button. The following screen displays.

Figure 19 ZyXEL Utility: WPS - Information



The following table describes the labels in this screen.

Table 12 Mac OS X: WPS - Information

LABEL	DESCRIPTION
State	This field indicates whether the selected AP is configured or not.
Version	This field indicates the selected AP's WPS version.
Authentication Type	This field indicates the type of authentication that is required by the AP.
Encryption Type	This field indicates the type of encryption used by the AP.
Config Methods	This field indicates whether the AP is functioning as a WPS **Enrollee**, **Registrar**, or if its configuration status is unknown.

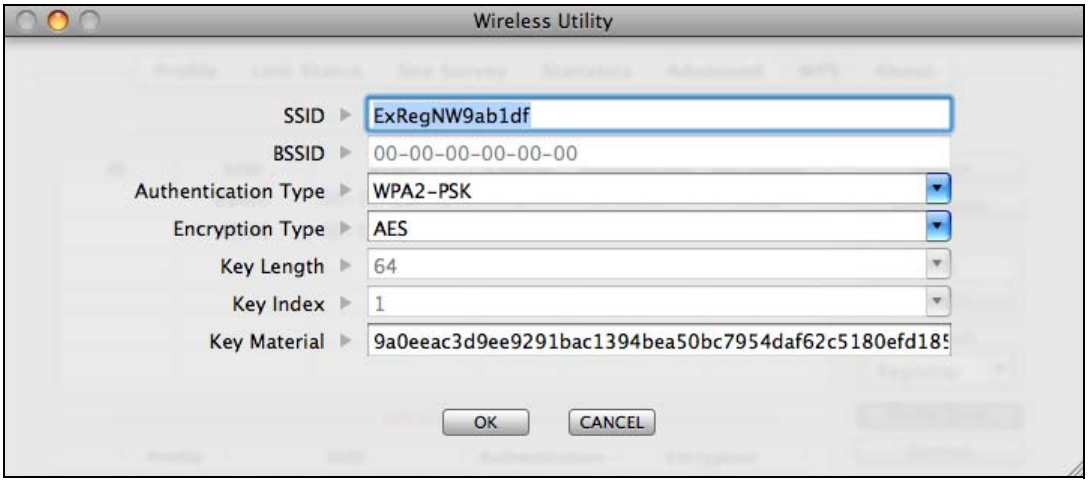
Table 12 Mac OS X: WPS - Information (continued)

LABEL	DESCRIPTION
Device Password ID	This field indicates whether device requires PBC or PIN for its method of password registration.
AP Setup Locked	This field indicates whether the AP has entered a setup locked state or not.
UUID-E	This field indicates the Universally Unique IDentifier (UUID) element of the AP if it is operating as an **Enrollee**.
Selected Register	This field indicates the AP's selected register.
RF Bands	This field indicates which RF band(s) the AP is using.

3.10.2 The Profile Details Screen

While in the WPS screen, you can view information about any profile in the **WPS Profile List**. Click the **Profile Details** button. The following screen displays.

Figure 20 ZyXEL Utility: WPS - Profile Details



The following table describes the labels in this screen.

Table 13 Mac OS X: WPS - Profile Details

LABEL	DESCRIPTION
SSID	This field indicates the automatically generated SSID used for your current WPS session. You can also edit it. Enter up to 32 standard English alphanumeric characters. Spaces, underscores and punctuation marks are allowed.
BSSID	This field indicates your WPS profile's BSSID.
Authentication Type	Select an authentication type to use for creating secure connections, or use the default as selected by the N220.
Encryption Type	Select an encryption type to use for creating secure connections, or use the default as selected by the N220.

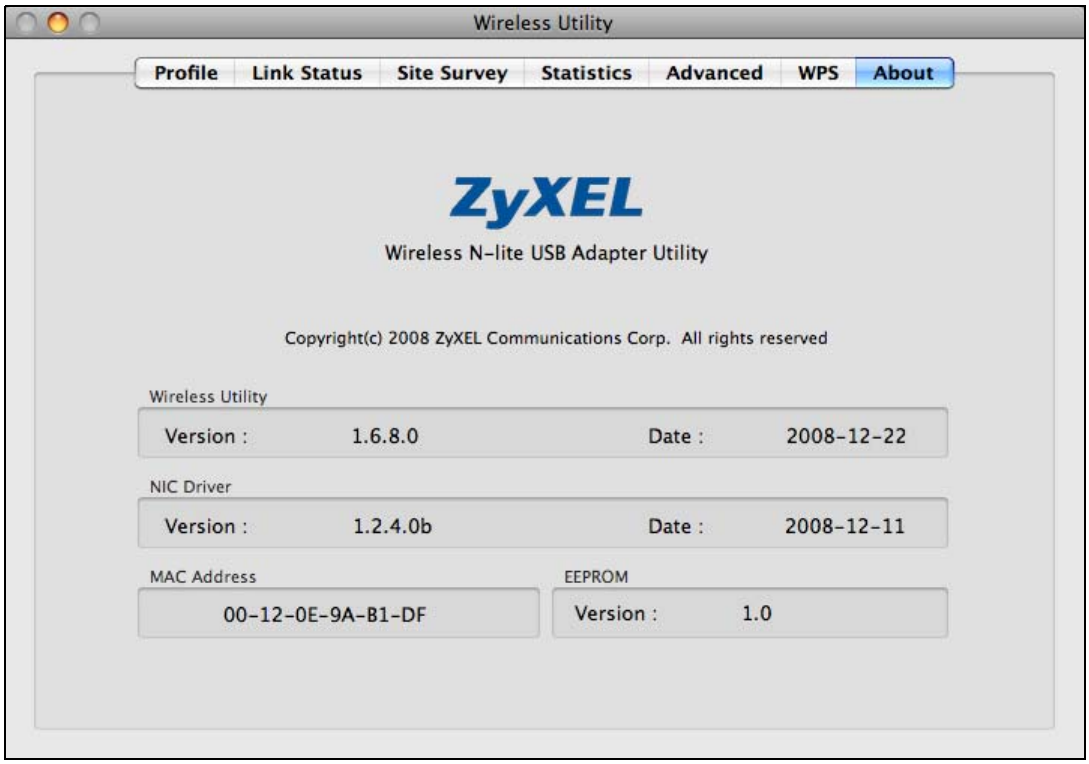
Table 13 Mac OS X: WPS - Profile Details (continued)

LABEL	DESCRIPTION
Key Length	This field indicates the length of the encryption key to use for creating secure connections. For WPS connections it is always 64-bit.
Key Index	This field indicates key index value to use for creating secure connections. For WPS connections it is always 1.
Key Material	This is the random string of letters and numbers used as the encryption key seed. An encryption key seed helps your N220 generate mathmatically random numbers than cannot be second guessed easily by would be malefactors
OK	Click this button to save your settings and return to the previous screen.
CANCEL	Click this button to close this dialoge without saving and return to the previous screen.

3.11 The About Screen

This screen shows you the driver, utility version, and MAC address of your N220.

Figure 21 ZyXEL Utility: About



The following table describes the labels in this screen.

Table 14 Mac OS X: About

LABEL	DESCRIPTION
Wireless Utility	This section displays the version number and release date of the N220's wireless utility application.
NIC Driver	This section displays the version number and release date of the N220's device driver.
MAC Address	This field displays the N220 Media Access Control (MAC) address.
EEPROM	This field displays the Electrically Erasable Programmable Read-Only Memory (EEPROM) version currently in use by the N220.

4

Troubleshooting

4.1 Overview

This chapter offers some suggestions to solve problems you might encounter. The potential problems are divided into the following categories.

- Power, Hardware Connections, and LEDs
- Accessing the ZyXEL Utility
- Link Quality
- Problems Communicating with Other Computers

4.2 Power, Hardware Connections, and LEDs

The N220 does not turn on. None of the LEDs turn on.

1. Make sure the N220 is correctly installed.
2. Restart the computer to which the N220 is attached.
3. If the problem continues, contact the vendor.

One of the LEDs does not behave as expected.

1. Make sure you understand the normal behavior of the LED. See Section 1.2 on page 14.
2. Check the hardware connection.
3. Restart the computer to which the N220 is attached.

4 If the problem continues, contact the vendor.

4.3 Accessing the ZyXEL Utility

I cannot access the ZyXEL Utility

1 Make sure the N220 is properly inserted and the LEDs are on.

2 Install the N220 on another computer.

3 If the error persists, you may have a hardware problem. In this case, you should contact your vendor.

4.4 Link Quality

The link quality and/or signal strength is poor.

1 Scan for and connect to another AP with a better link quality using the **Site Survey** screen.

2 Move your computer closer to the AP or the peer computer(s) within the transmission range.

3 There may be too much radio interference (for example from a microwave oven, or another AP using the same channel) around your wireless network. Lower the output power of each AP.

4 Make sure there are not too many wireless stations connected to a wireless network.

4.5 Problems Communicating with Other Computers

The computer with the N220 installed cannot communicate with the other computer(s).

In Infrastructure Mode

- Make sure that the AP and the associated computers are turned on and working properly.
- Make sure the N220 computer and the associated AP use the same SSID.
- Change the AP and the associated wireless clients to use another radio channel if interference is high.
- Make sure that the computer and the AP share the same security option and key. Verify the settings in the **Profile Authentication & Security** screen.
- If you are using WPA(2) or WPA(2)-PSK security, try changing your encryption type from TKIP to AES or vice versa.

In Ad-Hoc Mode

- Verify that the peer computer(s) is turned on.
- Make sure the N220 computer and the peer computer(s) are using the same SSID and channel.
- Make sure that the computer and the peer computer(s) share the same security settings.
- Change the wireless clients to use another radio channel if interference is high.

5

Product Specifications

Table 15 Product Specifications

PHYSICAL AND ENVIRONMENTAL	
Product Name	N220 Wireless N-lite USB Adapter
Interface	USB 2.0
Standards	IEEE 802.11b IEEE 802.11g IEEE 802.11n
Operating Frequency	2.4GHZ
Antenna Type	Chip
Operating Temperature	0 - 50 degrees Celsius
Storage Temperature	-30 - 70 degrees Celsius
Operating Humidity	20 - 90% (non-condensing)
Storage Humidity	10 - 90% (non-condensing)
Voltage	5V
Power Saving Mode	Yes
Current Consumption	Transmit: <300 mA Receive: <160 mA
Device Weight	3 g
Device Dimensions	18 mm (L) x 6 mm (W) x 36 mm (H)
RADIO SPECIFICATIONS	

Table 15 Product Specifications (continued)

Transmit Power (+/- 1.5 dB)	802.11b: 1/2/5.5/11M: 18.5 dBm 802.11g: 54/48M: 15dBm 24/36M: 15dBm 12/18M: 16dBm 6/9M: 16.5 dBm 802.11n: @ HT20 MCS0~MCS07: 15.5 dBm @ HT40 MCS0~MCS07: 15.5 dBm
Receiver Sensitivity	802.11b: 11Mbps at -82dBm 802.11g: 54Mbps at -68dBm 802.11n: HT20 at -64dBm HT40 at -62dBm
WIRELESS STANDARDS	
IEEE 802.11b	Dynamically shifts between 11, 5.5, 2, and 1 Mbps network speed.
Operation Frequency	2.412GHz~2.472GHz
Operation Channels	N. America &Taiwan 2.412GHz~ 2.462GHz 1-11 Euro ETSI 2.412GHz~ 2.472GHz 1-13
IEEE 802.11g	Dynamically shifts between 54, 48, 36, 24, 18, 12, 9 and 6 Mbps network speed.
Operation Frequency	2.412GHz~2.472GHz
Operation Channels	N. America &Taiwan 2.412GHz~ 2.462GHz 1-11 Euro ETSI 2.412GHz~ 2.472GHz 1-13
IEEE 802.11n	
Downstream data rate	150 Mbps
Upstream data rate	150 Mbps
Operation Frequency	2.412GHz~ 2.472GHz 1-13

Table 15 Product Specifications (continued)

Operation Channels	N. America & Taiwan HT20 2.412GHz~ 2.462GHz 1-11 N. America & Taiwan HT40 2.422GHz~ 2.452GHz 3-9 Euro ETSI HT20 2.412GHz~ 2.472GHz 1-13 Euro ETSI HT40 2.422GHz~ 2.462GHz 3-11
Networking Mode	Infrastructure, Ad-Hoc, SoftAP Support
Approvals	Safety European Union: EN60950-1 (CE-LVD) EMI United States: FCC Part 15B Class B Canada: ICES-003 European Union: CE EN 55022 Class B Australia: C-Tick EMS European Union: CE EN55024 RF United States: FCC Part 15C Canada: RSS-210 European Union: CE EN 300 328 Taiwan: NCC LP0002 Wi-Fi Certification 11 b/g/n WPA/WPA2/WPS Microsoft Certification WHQL: Windows 7 (32- and 64-bit), Windows Vista (32- and 64-bit), Windows XP (32- and 64-bit), Windows 2000
SOFTWARE SPECIFICATIONS	
Device Drivers	Windows 7 (32- and 64-bit) Windows Vista (32- and 64-bit) Windows XP (32- and 64-bit) Windows 2000 Mac OS X (10.3/10.4/10.5)
WIRELESS FEATURES	
Wireless Security	WEP 64bit, 128bit, WPA, WPA-PSK, WPA2, WPA2-PSK 802.1x (EAP-TLS, EAP-TTLS, EAP-PEAP), WPS. Note: EAP-TTLS is not supported in Windows Vista

Table 15 Product Specifications (continued)

Wireless QoS	Wi-Fi Multi Media (WMM)
Wi-Fi Protected Setup (WPS)	Push button configuration Use device's PIN Use AP or Router's PIN
Other	WMM power-saving support Compatible with Windows Zero Configuration

A

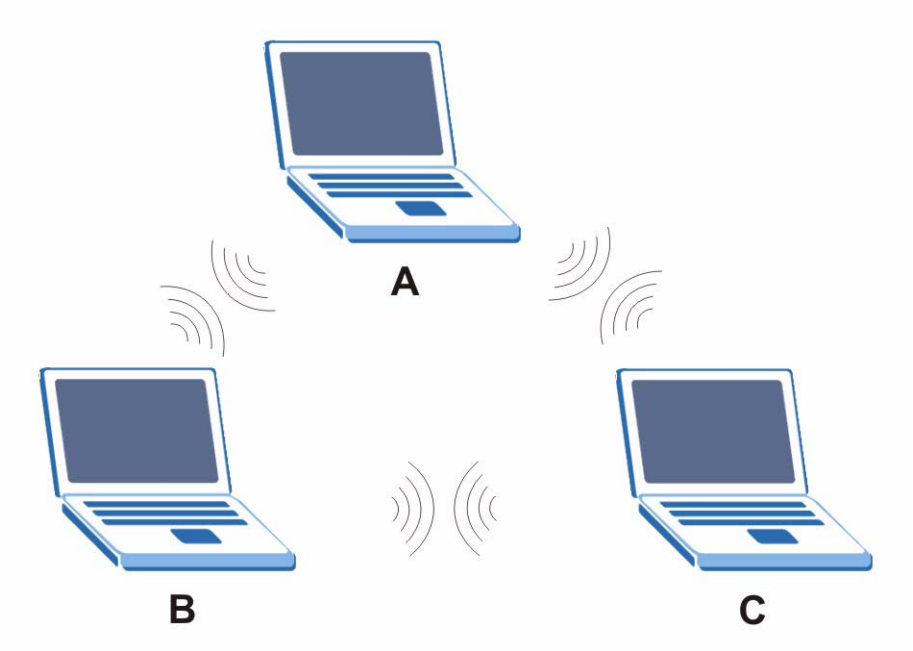
Wireless LANs

This appendix discusses ad-hoc and infrastructure wireless LAN topologies.

Ad-hoc Wireless LAN Configuration

The simplest WLAN configuration is an independent (Ad-hoc) WLAN that connects a set of computers with wireless adapters (A, B, C). Any time two or more wireless adapters are within range of each other, they can set up an independent network, which is commonly referred to as an ad-hoc network or Independent Basic Service Set (IBSS). The following diagram shows an example of notebook computers using wireless adapters to form an ad-hoc wireless LAN.

Figure 22 Peer-to-Peer Communication in an Ad-hoc Network

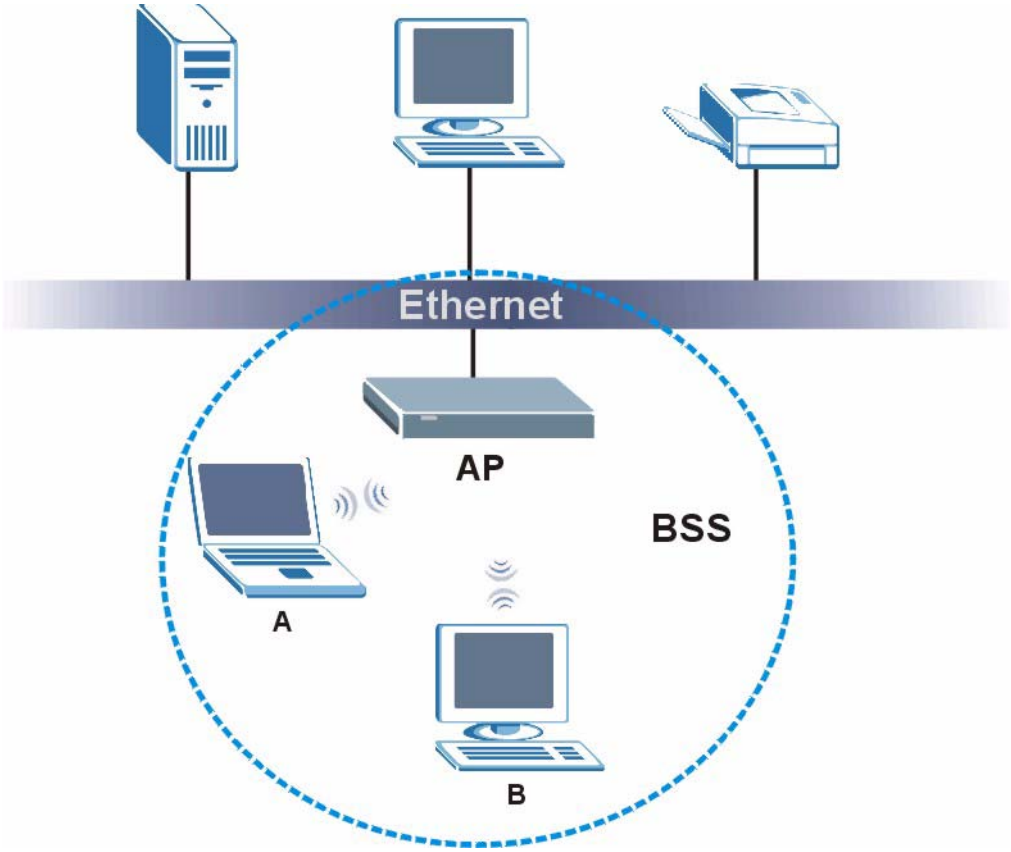


BSS

A Basic Service Set (BSS) exists when all communications between wireless clients or between a wireless client and a wired network client go through one access point (AP).

Intra-BSS traffic is traffic between wireless clients in the BSS. When Intra-BSS is enabled, wireless client **A** and **B** can access the wired network and communicate with each other. When Intra-BSS is disabled, wireless client **A** and **B** can still access the wired network but cannot communicate with each other.

Figure 23 Basic Service Set



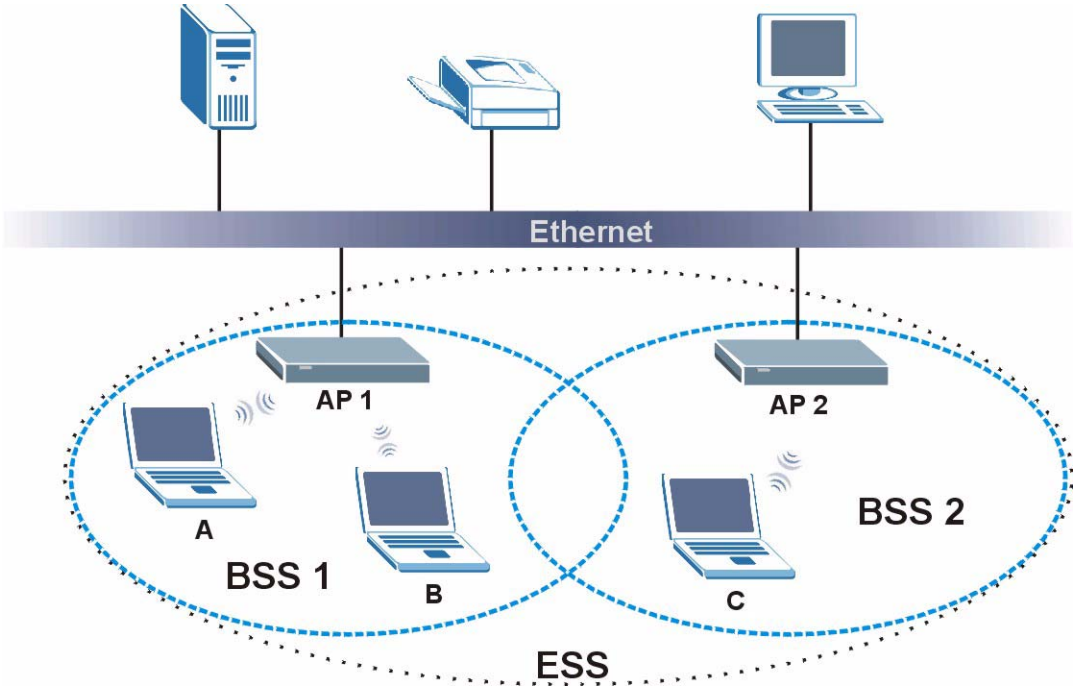
ESS

An Extended Service Set (ESS) consists of a series of overlapping BSSs, each containing an access point, with each access point connected together by a wired network. This wired connection between APs is called a Distribution System (DS).

This type of wireless LAN topology is called an Infrastructure WLAN. The Access Points not only provide communication with the wired network but also mediate wireless network traffic in the immediate neighborhood.

An ESSID (ESS IDentification) uniquely identifies each ESS. All access points and their associated wireless clients within the same ESS must have the same ESSID in order to communicate.

Figure 24 Infrastructure WLAN



Channel

A channel is the radio frequency(ies) used by wireless devices to transmit and receive data. Channels available depend on your geographical area. You may have a choice of channels (for your region) so you should use a channel different from an adjacent AP (access point) to reduce interference. Interference occurs when radio signals from different access points overlap causing interference and degrading performance.

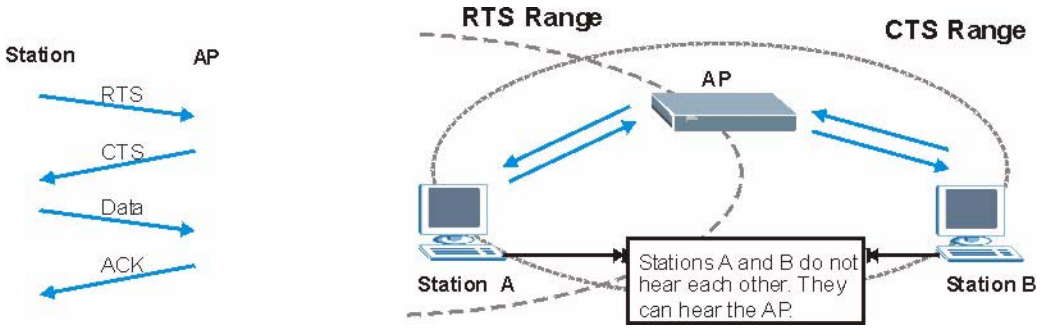
Adjacent channels partially overlap however. To avoid interference due to overlap, your AP should be on a channel at least five channels away from a channel that an

adjacent AP is using. For example, if your region has 11 channels and an adjacent AP is using channel 1, then you need to select a channel between 6 or 11.

RTS/CTS

A hidden node occurs when two stations are within range of the same access point, but are not within range of each other. The following figure illustrates a hidden node. Both stations (STA) are within range of the access point (AP) or wireless gateway, but out-of-range of each other, so they cannot "hear" each other, that is they do not know if the channel is currently being used. Therefore, they are considered hidden from each other.

Figure 25 RTS/CTS



When station **A** sends data to the AP, it might not know that the station **B** is already using the channel. If these two stations send data at the same time, collisions may occur when both sets of data arrive at the AP at the same time, resulting in a loss of messages for both stations.

RTS/CTS is designed to prevent collisions due to hidden nodes. An **RTS/CTS** defines the biggest size data frame you can send before an RTS (Request To Send)/CTS (Clear to Send) handshake is invoked.

When a data frame exceeds the **RTS/CTS** value you set (between 0 to 2432 bytes), the station that wants to transmit this frame must first send an RTS (Request To Send) message to the AP for permission to send it. The AP then responds with a CTS (Clear to Send) message to all other stations within its range to notify them to defer their transmission. It also reserves and confirms with the requesting station the time frame for the requested transmission.

Stations can send frames smaller than the specified **RTS/CTS** directly to the AP without the RTS (Request To Send)/CTS (Clear to Send) handshake.

You should only configure **RTS/CTS** if the possibility of hidden nodes exists on your network and the "cost" of resending large frames is more than the extra network overhead involved in the RTS (Request To Send)/CTS (Clear to Send) handshake.

If the **RTS/CTS** value is greater than the **Fragmentation Threshold** value (see next), then the RTS (Request To Send)/CTS (Clear to Send) handshake will never occur as data frames will be fragmented before they reach **RTS/CTS** size.

Note: Enabling the RTS Threshold causes redundant network overhead that could negatively affect the throughput performance instead of providing a remedy.

Fragmentation Threshold

A **Fragmentation Threshold** is the maximum data fragment size (between 256 and 2432 bytes) that can be sent in the wireless network before the AP will fragment the packet into smaller data frames.

A large **Fragmentation Threshold** is recommended for networks not prone to interference while you should set a smaller threshold for busy networks or networks that are prone to interference.

If the **Fragmentation Threshold** value is smaller than the **RTS/CTS** value (see previously) you set then the RTS (Request To Send)/CTS (Clear to Send) handshake will never occur as data frames will be fragmented before they reach **RTS/CTS** size.

Preamble Type

Preamble is used to signal that data is coming to the receiver. Short and long refer to the length of the synchronization field in a packet.

Short preamble increases performance as less time sending preamble means more time for sending data. All IEEE 802.11 compliant wireless adapters support long preamble, but not all support short preamble.

Use long preamble if you are unsure what preamble mode other wireless devices on the network support, and to provide more reliable communications in busy wireless networks.

Use short preamble if you are sure all wireless devices on the network support it, and to provide more efficient communications.

Use the dynamic setting to automatically use short preamble when all wireless devices on the network support it, otherwise the N220 uses long preamble.

Note: The wireless devices MUST use the same preamble mode in order to communicate.

IEEE 802.11g Wireless LAN

IEEE 802.11g is fully compatible with the IEEE 802.11b standard. This means an IEEE 802.11b adapter can interface directly with an IEEE 802.11g access point (and vice versa) at 11 Mbps or lower depending on range. IEEE 802.11g has several intermediate rate steps between the maximum and minimum data rates. The IEEE 802.11g data rate and modulation are as follows:

Table 16 IEEE 802.11g

DATA RATE (MBPS)	MODULATION
1	DBPSK (Differential Binary Phase Shift Keyed)
2	DQPSK (Differential Quadrature Phase Shift Keying)
5.5 / 11	CCK (Complementary Code Keying)
6/9/12/18/24/36/ 48/54	OFDM (Orthogonal Frequency Division Multiplexing)

Wireless Security Overview

Wireless security is vital to your network to protect wireless communication between wireless clients, access points and the wired network.

Wireless security methods available on the N220 are data encryption, wireless client authentication, restricting access by device MAC address and hiding the N220 identity.

The following figure shows the relative effectiveness of these wireless security methods available on your N220.

Table 17 Wireless Security Levels

SECURITY LEVEL	SECURITY TYPE
Least Secure	Unique SSID (Default)
	Unique SSID with Hide SSID Enabled
	MAC Address Filtering
	WEP Encryption
	IEEE802.1x EAP with RADIUS Server Authentication
	Wi-Fi Protected Access (WPA)
Most Secure	WPA2

Note: You must enable the same wireless security settings on the N220 and on all wireless clients that you want to associate with it.

IEEE 802.1x

In June 2001, the IEEE 802.1x standard was designed to extend the features of IEEE 802.11 to support extended authentication as well as providing additional accounting and control features. It is supported by Windows XP and a number of network devices. Some advantages of IEEE 802.1x are:

- User based identification that allows for roaming.
- Support for RADIUS (Remote Authentication Dial In User Service, RFC 2138, 2139) for centralized user profile and accounting management on a network RADIUS server.
- Support for EAP (Extensible Authentication Protocol, RFC 2486) that allows additional authentication methods to be deployed with no changes to the access point or the wireless clients.

RADIUS

RADIUS is based on a client-server model that supports authentication, authorization and accounting. The access point is the client and the server is the RADIUS server. The RADIUS server handles the following tasks:

- Authentication

  Determines the identity of the users.
- Authorization

  Determines the network services available to authenticated users once they are connected to the network.
- Accounting

  Keeps track of the client's network activity.

RADIUS is a simple package exchange in which your AP acts as a message relay between the wireless client and the network RADIUS server.

Types of RADIUS Messages

The following types of RADIUS messages are exchanged between the access point and the RADIUS server for user authentication:

- Access-Request

  Sent by an access point requesting authentication.

- Access-Reject

  Sent by a RADIUS server rejecting access.

- Access-Accept

  Sent by a RADIUS server allowing access.

- Access-Challenge

  Sent by a RADIUS server requesting more information in order to allow access. The access point sends a proper response from the user and then sends another Access-Request message.

The following types of RADIUS messages are exchanged between the access point and the RADIUS server for user accounting:

- Accounting-Request

  Sent by the access point requesting accounting.

- Accounting-Response

  Sent by the RADIUS server to indicate that it has started or stopped accounting.

In order to ensure network security, the access point and the RADIUS server use a shared secret key, which is a password, they both know. The key is not sent over the network. In addition to the shared key, password information exchanged is also encrypted to protect the network from unauthorized access.

Types of EAP Authentication

This section discusses some popular authentication types: EAP-MD5, EAP-TLS, EAP-TTLS, PEAP and LEAP. Your wireless LAN device may not support all authentication types.

EAP (Extensible Authentication Protocol) is an authentication protocol that runs on top of the IEEE 802.1x transport mechanism in order to support multiple types of user authentication. By using EAP to interact with an EAP-compatible RADIUS server, an access point helps a wireless station and a RADIUS server perform authentication.

The type of authentication you use depends on the RADIUS server and an intermediary AP(s) that supports IEEE 802.1x. .

For EAP-TLS authentication type, you must first have a wired connection to the network and obtain the certificate(s) from a certificate authority (CA). A certificate (also called digital IDs) can be used to authenticate users and a CA issues certificates and guarantees the identity of each certificate owner.

EAP-MD5 (Message-Digest Algorithm 5)

MD5 authentication is the simplest one-way authentication method. The authentication server sends a challenge to the wireless client. The wireless client 'proves' that it knows the password by encrypting the password with the challenge and sends back the information. Password is not sent in plain text.

However, MD5 authentication has some weaknesses. Since the authentication server needs to get the plaintext passwords, the passwords must be stored. Thus someone other than the authentication server may access the password file. In addition, it is possible to impersonate an authentication server as MD5 authentication method does not perform mutual authentication. Finally, MD5 authentication method does not support data encryption with dynamic session key. You must configure WEP encryption keys for data encryption.

EAP-TLS (Transport Layer Security)

With EAP-TLS, digital certifications are needed by both the server and the wireless clients for mutual authentication. The server presents a certificate to the client. After validating the identity of the server, the client sends a different certificate to the server. The exchange of certificates is done in the open before a secured tunnel is created. This makes user identity vulnerable to passive attacks. A digital certificate is an electronic ID card that authenticates the sender's identity. However, to implement EAP-TLS, you need a Certificate Authority (CA) to handle certificates, which imposes a management overhead.

EAP-TTLS (Tunneled Transport Layer Service)

EAP-TTLS is an extension of the EAP-TLS authentication that uses certificates for only the server-side authentications to establish a secure connection. Client authentication is then done by sending username and password through the secure connection, thus client identity is protected. For client authentication, EAP-TTLS supports EAP methods and legacy authentication methods such as PAP, CHAP, MS-CHAP and MS-CHAP v2.

PEAP (Protected EAP)

Like EAP-TTLS, server-side certificate authentication is used to establish a secure connection, then use simple username and password methods through the secured connection to authenticate the clients, thus hiding client identity. However, PEAP only supports EAP methods, such as EAP-MD5, EAP-MSCHAPv2 and EAP-GTC (EAP-Generic Token Card), for client authentication. EAP-GTC is implemented only by Cisco.

LEAP

LEAP (Lightweight Extensible Authentication Protocol) is a Cisco implementation of IEEE 802.1x.

Dynamic WEP Key Exchange

The AP maps a unique key that is generated with the RADIUS server. This key expires when the wireless connection times out, disconnects or reauthentication times out. A new WEP key is generated each time reauthentication is performed.

If this feature is enabled, it is not necessary to configure a default encryption key in the wireless security configuration screen. You may still configure and store keys, but they will not be used while dynamic WEP is enabled.

Note: EAP-MD5 cannot be used with Dynamic WEP Key Exchange

For added security, certificate-based authentications (EAP-TLS, EAP-TTLS and PEAP) use dynamic keys for data encryption. They are often deployed in corporate environments, but for public deployment, a simple user name and password pair is more practical. The following table is a comparison of the features of authentication types.

Table 18 Comparison of EAP Authentication Types

	EAP-MD5	EAP-TLS	EAP-TTLS	PEAP	LEAP
Mutual Authentication	No	Yes	Yes	Yes	Yes
Certificate – Client	No	Yes	Optional	Optional	No
Certificate – Server	No	Yes	Yes	Yes	No
Dynamic Key Exchange	No	Yes	Yes	Yes	Yes
Credential Integrity	None	Strong	Strong	Strong	Moderate
Deployment Difficulty	Easy	Hard	Moderate	Moderate	Moderate
Client Identity Protection	No	No	Yes	Yes	No

WPA and WPA2

Wi-Fi Protected Access (WPA) is a subset of the IEEE 802.11i standard. WPA2 (IEEE 802.11i) is a wireless security standard that defines stronger encryption, authentication and key management than WPA.

Key differences between WPA or WPA2 and WEP are improved data encryption and user authentication.

If both an AP and the wireless clients support WPA2 and you have an external RADIUS server, use WPA2 for stronger data encryption. If you don't have an external RADIUS server, you should use WPA2-PSK (WPA2-Pre-Shared Key) that only requires a single (identical) password entered into each access point, wireless gateway and wireless client. As long as the passwords match, a wireless client will be granted access to a WLAN.

If the AP or the wireless clients do not support WPA2, just use WPA or WPA-PSK depending on whether you have an external RADIUS server or not.

Select WEP only when the AP and/or wireless clients do not support WPA or WPA2. WEP is less secure than WPA or WPA2.

Encryption

Both WPA and WPA2 improve data encryption by using Temporal Key Integrity Protocol (TKIP), Message Integrity Check (MIC) and IEEE 802.1x. WPA and WPA2 use Advanced Encryption Standard (AES) in the Counter mode with Cipher block chaining Message authentication code Protocol (CCMP) to offer stronger encryption than TKIP.

TKIP uses 128-bit keys that are dynamically generated and distributed by the authentication server. AES (Advanced Encryption Standard) is a block cipher that uses a 256-bit mathematical algorithm called Rijndael. They both include a per-packet key mixing function, a Message Integrity Check (MIC) named Michael, an extended initialization vector (IV) with sequencing rules, and a re-keying mechanism.

WPA and WPA2 regularly change and rotate the encryption keys so that the same encryption key is never used twice.

The RADIUS server distributes a Pairwise Master Key (PMK) key to the AP that then sets up a key hierarchy and management system, using the PMK to dynamically generate unique data encryption keys to encrypt every data packet that is wirelessly communicated between the AP and the wireless clients. This all happens in the background automatically.

The Message Integrity Check (MIC) is designed to prevent an attacker from capturing data packets, altering them and resending them. The MIC provides a strong mathematical function in which the receiver and the transmitter each compute and then compare the MIC. If they do not match, it is assumed that the data has been tampered with and the packet is dropped.

By generating unique data encryption keys for every data packet and by creating an integrity checking mechanism (MIC), with TKIP and AES it is more difficult to decrypt data on a Wi-Fi network than WEP and difficult for an intruder to break into the network.

The encryption mechanisms used for WPA(2) and WPA(2)-PSK are the same. The only difference between the two is that WPA(2)-PSK uses a simple common password, instead of user-specific credentials. The common-password approach makes WPA(2)-PSK susceptible to brute-force password-guessing attacks but it's still an improvement over WEP as it employs a consistent, single, alphanumeric password to derive a PMK which is used to generate unique temporal encryption keys. This prevent all wireless devices sharing the same encryption keys. (a weakness of WEP)

User Authentication

WPA and WPA2 apply IEEE 802.1x and Extensible Authentication Protocol (EAP) to authenticate wireless clients using an external RADIUS database. WPA2 reduces the number of key exchange messages from six to four (CCMP 4-way handshake) and shortens the time required to connect to a network. Other WPA2 authentication features that are different from WPA include key caching and pre-authentication. These two features are optional and may not be supported in all wireless devices.

Key caching allows a wireless client to store the PMK it derived through a successful authentication with an AP. The wireless client uses the PMK when it tries to connect to the same AP and does not need to go with the authentication process again.

Pre-authentication enables fast roaming by allowing the wireless client (already connecting to an AP) to perform IEEE 802.1x authentication with another AP before connecting to it.

Wireless Client WPA Supplicants

A wireless client supplicant is the software that runs on an operating system instructing the wireless client how to use WPA. At the time of writing, the most widely available supplicant is the WPA patch for Windows XP, Funk Software's Odyssey client.

The Windows XP patch is a free download that adds WPA capability to Windows XP's built-in "Zero Configuration" wireless client. However, you must run Windows XP to use it.

WPA(2) with RADIUS Application Example

To set up WPA(2), you need the IP address of the RADIUS server, its port number (default is 1812), and the RADIUS shared secret. A WPA(2) application example with an external RADIUS server looks as follows. "A" is the RADIUS server. "DS" is the distribution system.

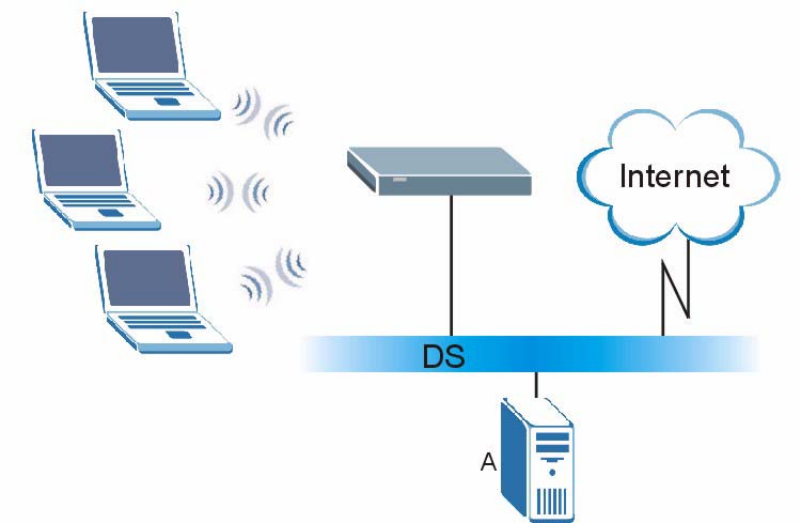
1 The AP passes the wireless client's authentication request to the RADIUS server.

2 The RADIUS server then checks the user's identification against its database and grants or denies network access accordingly.

3 A 256-bit Pairwise Master Key (PMK) is derived from the authentication process by the RADIUS server and the client.

4 The RADIUS server distributes the PMK to the AP. The AP then sets up a key hierarchy and management system, using the PMK to dynamically generate unique data encryption keys. The keys are used to encrypt every data packet that is wirelessly communicated between the AP and the wireless clients.

Figure 26 WPA(2) with RADIUS Application Example



WPA(2)-PSK Application Example

A WPA(2)-PSK application looks as follows.

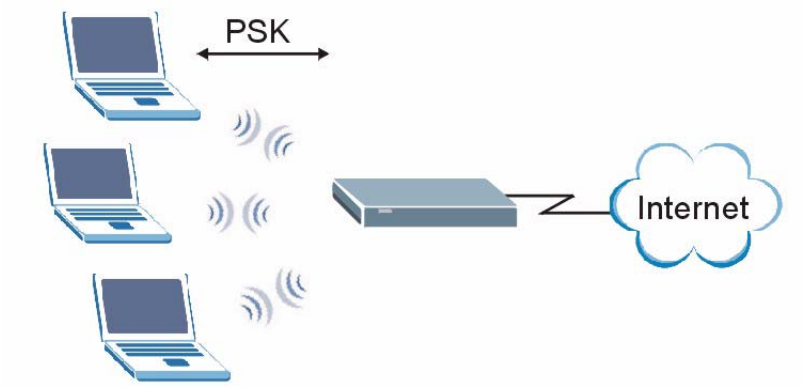
1 First enter identical passwords into the AP and all wireless clients. The Pre-Shared Key (PSK) must consist of between 8 and 63 ASCII characters or 64 hexadecimal characters (including spaces and symbols).

2 The AP checks each wireless client's password and allows it to join the network only if the password matches.

3 The AP and wireless clients generate a common PMK (Pairwise Master Key). The key itself is not sent over the network, but is derived from the PSK and the SSID.

4 The AP and wireless clients use the TKIP or AES encryption process, the PMK and information exchanged in a handshake to create temporal encryption keys. They use these keys to encrypt data exchanged between them.

Figure 27 WPA(2)-PSK Authentication



Security Parameters Summary

Refer to this table to see what other security parameters you should configure for each authentication method or key management protocol type. MAC address filters are not dependent on how you configure these security features.

Table 19 Wireless Security Relational Matrix

AUTHENTICATION METHOD/ KEY MANAGEMENT PROTOCOL	ENCRYPTION METHOD	ENTER MANUAL KEY	IEEE 802.1X
Open	None	No	Disable
			Enable without Dynamic WEP Key
Open	WEP	No	Enable with Dynamic WEP Key
		Yes	Enable without Dynamic WEP Key
		Yes	Disable
Shared	WEP	No	Enable with Dynamic WEP Key
		Yes	Enable without Dynamic WEP Key
		Yes	Disable
WPA	TKIP/AES	No	Enable
WPA-PSK	TKIP/AES	Yes	Disable
WPA2	TKIP/AES	No	Enable
WPA2-PSK	TKIP/AES	Yes	Disable

Antenna Overview

An antenna couples RF signals onto air. A transmitter within a wireless device sends an RF signal to the antenna, which propagates the signal through the air. The antenna also operates in reverse by capturing RF signals from the air.

Positioning the antennas properly increases the range and coverage area of a wireless LAN.

Antenna Characteristics

Frequency

An antenna in the frequency of 2.4GHz (IEEE 802.11b and IEEE 802.11g) or 5GHz (IEEE 802.11a) is needed to communicate efficiently in a wireless LAN

Radiation Pattern

A radiation pattern is a diagram that allows you to visualize the shape of the antenna's coverage area.

Antenna Gain

Antenna gain, measured in dB (decibel), is the increase in coverage within the RF beam width. Higher antenna gain improves the range of the signal for better communications.

For an indoor site, each 1 dB increase in antenna gain results in a range increase of approximately 2.5%. For an unobstructed outdoor site, each 1dB increase in gain results in a range increase of approximately 5%. Actual results may vary depending on the network environment.

Antenna gain is sometimes specified in dBi, which is how much the antenna increases the signal power compared to using an isotropic antenna. An isotropic antenna is a theoretical perfect antenna that sends out radio signals equally well in all directions. dBi represents the true gain that the antenna provides.

Types of Antennas for WLAN

There are two types of antennas used for wireless LAN applications.

- Omni-directional antennas send the RF signal out in all directions on a horizontal plane. The coverage area is torus-shaped (like a donut) which makes these antennas ideal for a room environment. With a wide coverage area, it is possible to make circular overlapping coverage areas with multiple access points.
- Directional antennas concentrate the RF signal in a beam, like a flashlight does with the light from its bulb. The angle of the beam determines the width of the coverage pattern. Angles typically range from 20 degrees (very directional) to 120 degrees (less directional). Directional antennas are ideal for hallways and outdoor point-to-point applications.

Positioning Antennas

In general, antennas should be mounted as high as practically possible and free of obstructions. In point-to–point application, position both antennas at the same height and in a direct line of sight to each other to attain the best performance.

For omni-directional antennas mounted on a table, desk, and so on, point the antenna up. For omni-directional antennas mounted on a wall or ceiling, point the antenna down. For a single AP application, place omni-directional antennas as close to the center of the coverage area as possible.

For directional antennas, point the antenna in the direction of the desired coverage area.

B

Legal Information

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Certifications

Federal Communications Commission (FCC) Interference Statement

The device complies with Part 15 of FCC rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operations.

This device has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This device generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this device does cause harmful interference to radio/television reception, which can be determined by turning the device off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna.
2. Increase the separation between the equipment and the receiver.
3. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
4. Consult the dealer or an experienced radio/TV technician for help.

FCC Radiation Exposure Statement

- This device has been tested to the FCC exposure requirements (Specific Absorption Rate).
- This device complies with the requirements of Health Canada Safety Code 6 for Canada.
- Testing was performed on laptop computers with antennas at 5mm spacing. The maximum SAR value is: 0.77 W/kg. The device must not be collocated with any other antennas or transmitters.
- This equipment has been SAR-evaluated for use in laptops (notebooks) with side slot configuration.
- The device complies with FCC RF radiation exposure limits set forth for an uncontrolled environment, under 47 CFR 2.1093 paragraph (d)(2). End users must follow the specific operating instructions for satisfying RF exposure compliance. To maintain compliance with FCC RF exposure compliance requirements, please follow operation instruction as documented in this manual.
- This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
- IEEE 802.11b or 802.11g operation of this product in the U.S.A. is firmware-limited to channels 1 through 11.

Industry Canada Statement

This device complies with RSS-210 of the Industry Canada Rules. Operation is subject to the following two conditions:

1) this device may not cause interference and

2) this device must accept any interference, including interference that may cause undesired operation of the device

This device has been designed to operate with an antenna having a maximum gain of 3dBi.

Antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the EIRP is not more than required for successful communication.

IC Radiation Exposure Statement

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance.

注意！

依據 低功率電波輻射性電機管理辦法

第十二條 經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

第十四條 低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。
前項合法通信，指依電信規定作業之無線電信。低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

本機限在不干擾合法電臺與不受被干擾保障條件下於室內使用。
減少電磁波影響，請妥適使用。

Notices

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device has been designed for the WLAN 2.4 GHz network throughout the EC region and Switzerland, with restrictions in France.

This Class B digital apparatus complies with Canadian ICES-003. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

Viewing Certifications

1. Go to http://www.zyxel.com.
2. Select your product on the ZyXEL home page to go to that product's page.
3. Select the certification you wish to view from this page.

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